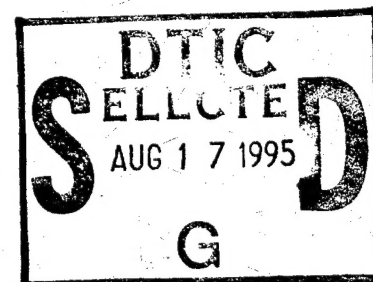

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ELMENDORF AFB, ALASKA

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RISK ASSESSMENT

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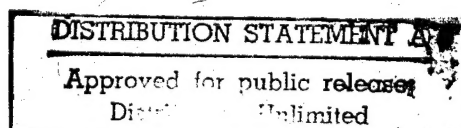


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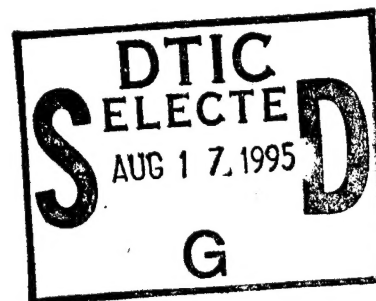
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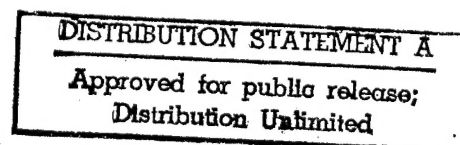
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CONTENTS

	<u>Page</u>
NOTICE	ii
REPORT DOCUMENTATION PAGE	iii
LIST OF FIGURES	x
LIST OF TABLES	xii
LIST OF ACRONYMS	xiv
EXECUTIVE SUMMARY	ES-1
1.0 INTRODUCTION	1-1
1.1 SCOPE OF HUMAN HEALTH BASELINE RISK ASSESSMENT	1-5
1.2 SCOPE OF ECOLOGICAL BASELINE RISK ASSESSMENT	1-7
1.3 REPORT ORGANIZATION	1-8
2.0 PAST AND PRESENT IRP ACTIVITIES	2-1
2.1 PAST IRP ACTIVITIES	2-1
2.1.1 Phase I Records Search	2-1
2.1.2 Stage 1 RI/FS	2-1
2.1.3 Stage 2 RI/FS	2-3
2.1.4 Beach Tank Removals	2-3
2.1.5 Environmental Baseline Survey (Navigational Aid Building 101)	2-4
2.1.6 1993/1994 Site Survey	2-4
2.2 SITE STATUS IN 1994	2-6
2.3 KOTZEBUE LRRS 1994 REMEDIAL INVESTIGATION	2-7
2.3.1 Field Screening Techniques	2-10
2.3.1.1 Screening for Organic Vapors	2-10
2.3.1.2 Screening for TPH and PCB	2-10
2.3.2 Environmental Sampling Methods	2-10
2.3.2.1 Surface and Shallow Subsoil Sampling	2-10
2.3.2.2 Subsoil Sampling	2-10
2.3.2.3 Geotechnical Sampling	2-11
2.3.2.4 Lake Sediment Sampling	2-11

2.3.2.5	<i>Surface Water Sampling</i>	2-11
2.3.2.6	<i>Groundwater Sampling</i>	2-11
2.3.2.7	<i>Seawater Sampling</i>	2-11
2.3.3	Decontamination Procedures	2-11
2.3.4	Field Quality Assurance/Quality Control	2-12
2.3.4.1	<i>Field Activities Quality Control</i>	2-12
2.3.4.2	<i>Field Audits</i>	2-13
2.3.4.3	<i>Corrective Actions</i>	2-14
2.3.5	Analytical Program	2-14
2.3.5.1	<i>Contaminant Assessment</i>	2-14
2.3.5.2	<i>Natural Biodegradation Assessment</i>	2-17
2.3.5.3	<i>Fate and Transport Assessment</i>	2-17
2.3.6	QA/QC Program	2-19
2.3.6.1	<i>Data Quality Objectives</i>	2-19
2.3.6.2	<i>Laboratory Audits</i>	2-20
2.3.7	Data Reduction, Validation, and Reporting	2-21
2.3.7.1	<i>Data Reduction</i>	2-21
2.3.7.2	<i>Data Validation</i>	2-21
2.3.7.3	<i>Data Reporting</i>	2-23
3.0	ENVIRONMENTAL SETTING	3-1
3.1	PHYSIOGRAPHY	3-1
3.2	CLIMATE	3-2
3.3	GEOLOGY	3-3
3.4	GROUNDWATER	3-3
3.4.1	Subpermafrost Water	3-4
3.4.2	Suprapermafrost Water (Active Zone)	3-4
3.5	SURFACE WATER	3-6
3.5.1	Surface Water Occurrence	3-6
3.5.2	Surface Water Drainage	3-7
3.5.3	Surface Water Drinking Supply	3-8
3.6	OCEANOGRAPHY OF KOTZEBUE SOUND	3-8
3.7	BIOLOGICAL HABITATS	3-9
3.8	PLANT HABITATS	3-11
3.9	DEMOGRAPHICS	3-11
3.10	LAND USE	3-12

4.0 DATA EVALUATION	4-1
4.1 DATA EVALUATION	4-1
4.2 DEFINITION OF INVESTIGATIVE AREAS	4-2
5.0 BASELINE HUMAN HEALTH RISK ASSESSMENT	5-1
5.1 CONTAMINANTS OF POTENTIAL CONCERN	5-1
5.1.1 Risk-based Screening Assessment	5-1
5.1.2 COPC Concentrations for Reasonable Maximum Exposure Scenario ...	5-5
5.2 EXPOSURE ASSESSMENT	5-5
5.2.1 Site Characterization	5-5
5.2.2 Identification of Exposure Pathways	5-6
5.2.2.1 Contaminant Sources	5-6
5.2.2.2 Fate and Transport Within Contaminated Media	5-6
5.2.2.3 Exposure Points	5-7
5.2.2.4 Exposure Routes	5-7
5.2.2.5 Potential Human Receptors	5-7
5.2.3 Description of Exposure Pathways	5-7
5.2.3.1 Soil Exposure Pathway	5-8
5.2.3.2 Air Exposure Pathway	5-8
5.2.3.3 Groundwater Exposure Pathway	5-9
5.2.3.4 Surface Water Exposure Pathway	5-9
5.2.3.5 Sediment Exposure Pathway	5-10
5.2.3.6 Food Exposure Pathway	5-10
5.2.4 Quantification of Exposure Assessment	5-11
5.2.4.1 Inhalation Exposure	5-11
5.2.4.2 Incidental Ingestion of Soil	5-18
5.2.4.3 Dermal Contact with Soil or Sediments	5-19
5.2.4.4 Dermal Contact with Surface Water	5-20
5.2.4.5 Ingestion of Surface Water	5-21
5.2.4.6 Ingestion of Fish and Marine Mammals	5-22
5.2.4.7 Ingestion of Plants and Berries	5-26
5.2.4.8 Ingestion of Land Mammals	5-28
5.3 TOXICITY ASSESSMENT	5-31
5.3.1 Toxicity Values for Non-carcinogenic Chemicals	5-31
5.3.2 Toxicity Values for Carcinogenic Chemicals	5-31
5.3.3 Toxicity Values for Dermal Exposure	5-39
5.3.4 Toxicity Profiles	5-42

5.4 RISK CHARACTERIZATION	5-42
5.4.1 Carcinogenic Risks	5-42
5.4.2 Noncarcinogenic Health Effects	5-43
5.4.3 Risk Estimates	5-43
5.4.3.1 Inhalation Of Airborne Dust	5-44
5.4.3.2 Inhalation Of Volatile Chemicals	5-44
5.4.3.3 Ingestion of Soil/Sediment	5-44
5.4.3.4 Dermal Contact With Soil/Sediments	5-47
5.4.3.5 Dermal Contact with Surface Water	5-51
5.4.3.6 Ingestion of Surface Water	5-51
5.4.3.7 Ingestion of Fish and Seals	5-51
5.4.3.8 Ingestion of Berries	5-57
5.4.3.9 Ingestion of Caribou	5-57
5.4.4 Summary of Risk Estimates	5-57
5.5 UNCERTAINTY ANALYSIS	5-69
5.5.1 Representative Exposure Concentrations	5-69
5.5.2 Exposure Assumptions	5-70
5.5.3 Toxicity Evaluations	5-71
6.0 BASELINE ECOLOGICAL RISK ASSESSMENT	6-1
6.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN	6-1
6.1.1 Screening Assessment	6-1
6.1.2 COPEC Concentrations for Reasonable Maximum Exposure Scenario ..	6-2
6.2 ECOLOGICAL CHARACTERIZATION	6-5
6.2.1 Marine Communities	6-5
6.2.1.1 Plankton	6-5
6.2.1.2 Aquatic Plants and Attached Algae	6-6
6.2.1.3 Benthic Invertebrates	6-6
6.2.1.4 Fishes	6-7
6.2.1.5 Birds	6-8
6.2.1.6 Mammals	6-9
6.2.2 Freshwater Communities	6-10
6.2.2.1 Plankton	6-10
6.2.2.2 Benthic Invertebrates	6-10
6.2.2.3 Aquatic Plants	6-10
6.2.2.4 Birds	6-11

6.2.3	Terrestrial Communities	6-11
6.2.3.1	<i>Plants</i>	6-11
6.2.3.2	<i>Birds</i>	6-12
6.2.3.3	<i>Mammals</i>	6-12
6.2.4	Selection of Key Ecological Receptors	6-12
6.3	TOXICITY ASSESSMENT	6-13
6.3.1	Assessment and Measurement Endpoints	6-13
6.3.2	Uncertainty Factors Applied to Measurement Endpoints	6-14
6.4	EXPOSURE ASSESSMENT	6-15
6.4.1	Marine Environment	6-19
6.4.2	Terrestrial Environment	6-22
6.4.2.1	<i>Dietary Exposure Route</i>	6-22
6.4.2.2	<i>Water Intake Exposure Route</i>	6-25
6.4.2.3	<i>Soil Ingestion Exposure Route</i>	6-26
6.5	RISK CHARACTERIZATION	6-26
6.5.1	Aquatic Environment	6-27
6.5.2	Terrestrial Environment	6-27
6.5.2.1	<i>Dietary Exposure Route</i>	6-27
6.5.2.2	<i>Water Intake Exposure Route</i>	6-30
6.5.2.3	<i>Soil Ingestion Exposure Route</i>	6-30
6.5.3	Summary of Risk Estimates	6-30
6.6	UNCERTAINTY ANALYSIS	6-33
6.6.1	Aquatic Environment	6-33
6.6.2	Terrestrial Environment	6-35
7.0	REFERENCES	7-1

APPENDICES

- APPENDIX A. CONTAMINANT ANALYSES FOR EACH INVESTIGATIVE AREA
- APPENDIX B. SCREENING FOR CHEMICALS OF POTENTIAL CONCERN
- APPENDIX C. HARVEST AND CONSUMPTION OF ANIMALS AND PLANTS IN THE KOTZEBUE VICINITY

- APPENDIX D. CALCULATION OF NEAR-FIELD DILUTION IN KOTZEBUE SOUND
- APPENDIX E. TOXICOLOGICAL PROFILES OF DETECTED CHEMICALS OF POTENTIAL CONCERN
- APPENDIX F. RISK ESTIMATES FOR BASELINE HUMAN HEALTH RISK ASSESSMENT
- APPENDIX G. SPECIES IDENTIFIED IN THE KOTZEBUE AREA
- APPENDIX H. RISK ESTIMATES FOR BASELINE ECOLOGICAL RISK ASSESSMENT

FIGURES

<u>Number</u>		<u>Page</u>
1-1	Location of Kotzebue, Alaska	1-2
1-2	Location of the Kotzebue Long Range Radar Station, Alaska	1-3
1-3	Facility Locations at Kotzebue LRRS, Alaska	1-4
2-1	Sites and Areas of Concern Investigated During 1994 Remedial Investigation at Kotzebue LRRS, Alaska	2-8
4-1	Investigative Areas for Baseline Risk Assessment, Kotzebue LRRS, Alaska	4-3
4-2	Navigational Aid Buildings and White Alice Area, Kotzebue LRRS, Alaska	4-5
4-3	Beach Area, Kotzebue LRRS, Alaska	4-6
4-4	Western Drainage Area, Kotzebue LRRS, Alaska	4-7
4-5	Eastern Drainage Area, Kotzebue LRRS, Alaska	4-8
5-1	Human Health Exposure Pathways Evaluated for Kotzebue LRRS, Alaska	5-12
5-2	Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at the Navigational Aid Buildings and White Alice Area, Kotzebue LRRS, Alaska	5-64
5-3	Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at the Western Drainage Area, Kotzebue LRRS, Alaska	5-65
5-4	Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at the Eastern Drainage Area, Kotzebue LRRS, Alaska	5-66
5-5	Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at the Beach Area, Kotzebue LRRS, Alaska . .	5-67
5-6	Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at the Background Sampling Stations, Kotzebue LRRS, Alaska	5-68

6-1	Ecological Exposure Pathways Evaluated for Kotzebue LRRS, Alaska	6-18
6-2	Simplified Exposure Pathway for Marine Investigative Areas, Ecological Risk Assessment, Kotzebue LRRS, Alaska	6-20
6-3	Simplified Exposure Pathway for Terrestrial Investigative Areas, Ecological Risk Assessment, Kotzebue LRRS, Alaska	6-23
6-4	Locations of Samples for Which Concentrations of Xylenes, 2-Methyl- naphthalene, and 4-Nitrophenol in Soil Exceeded Hazard Quotient of One for Ground Squirrels in Dietary Pathway, Kotzebue LRRS, Alaska	6-34

TABLES

<u>Number</u>		<u>Page</u>
2-1	1988 Stage 1 RI/FS Site Identification	2-2
2-2	1993 Site Survey Areas of Concern	2-5
2-3	Summary of Field Activities Conducted During 1994 Remedial Investigation at Kotzebue LRRS, Alaska	2-9
2-4	Field Sampling and Analyses Summary for 1994 Remedial Investigation at Kotzebue LRRS, Alaska	2-15
2-5	Field Sampling and Analyses Summary for Geochemical Parameters for 1994 Remedial Investigation, Kotzebue LRRS, Alaska	2-18
2-6	Laboratory Analytical Data Review Process, 1994 Remedial Investigation, Kotzebue LRRS, Alaska	2-22
3-1	Mean Number of Days with Minimum Air Temperature Less Than 32° F at Kotzebue, Alaska	3-2
5-1	Chemicals of Potential Concern (COPC) by Media	5-3
5-2	Values Used in Assessing Exposure at Kotzebue LRRS	5-14
5-3	BCF, KOW, FCM, and BAF Values Used for Baseline Human Health Risk Assessment	5-24
5-4	KOW, BTF, and SCF Values Used for the Human Health Baseline Risk Assessment	5-29
5-5	Oral/Inhalation Chronic Non-Carcinogenic Toxicity Values for Kotzebue LRRS	5-32
5-6	Oral/Inhalation Carcinogenic toxicity Values for Kotzebue LRRS	5-36
5-7	Oral Absorption Efficiency Factors for Kotzebue LRRS	5-40
5-8	Estimated Risk Due to Inhalation	5-45
5-9	Estimated Risk from Inhalation of Dust	5-46
5-10	Estimated Risk from Ingestion of Soil/Sediment	5-48
5-11	Estimated Risk from Soil/Sediment Ingestion	5-49

5-12	Estimated Risk from Dermal Contact with Soil/Sediment	5-50
5-13	Estimated Risk from Dermal Contact with Soil/Sediment	5-52
5-14	Estimated Risk Due to Dermal Contact with Surface Water	5-53
5-15	Estimated Risk from Dermal Contact with Surface Water	5-54
5-16	Estimated Risk Due to Ingestion of Surface Water	5-55
5-17	Estimated Risk Due to Ingestion of Fish and Marine Mammals	5-56
5-18	Estimated Risk Due to Ingestion of Berries	5-58
5-19	Estimated Risk from Berry Ingestion	5-59
5-20	Estimated Risk Due to Ingestion of Caribou	5-60
5-21	Summary of Combined Risk Estimates for All Exposure Pathways for Each Investigative Area	5-61
5-22	Location of COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at Kotzebue LRRS	5-63
6-1	Chemicals of Potential Ecological Concern (COPEC) by Media at Kotzebue LRRS, Alaska	6-3
6-2	Extrapolated Oral Reference Doses of COPECs for Ringed Seal, Caribou, and Ground Squirrel, Kotzebue LRRS Ecological Baseline Risk Assessment . . .	6-16
6-3	Estimated Risk to Ringed Seal from the Dietary Exposure Route, Kotzebue LRRS, Alaska	6-28
6-4	Estimated Risk to Caribou from the Dietary Exposure Route, Kotzebue LRRS, Alaska	6-29
6-5	Estimated Risk to Ground Squirrels from the Dietary Exposure Route, Kotzebue LRRS, Alaska	6-29
6-6	Estimated Risk to Caribou from the Water Intake Exposure Route, Kotzebue LRRS, Alaska	6-31
6-7	Estimated Risk to Ground Squirrels from the Water Intake Exposure Route, Kotzebue LRRS, Alaska	6-31
6-8	Estimated Risk to Ground Squirrels from the Soil Ingestion Exposure Route, Kotzebue LRRS, Alaska	6-32

LIST OF ACRONYMS

AAC	Alaska Administrative Code
ADD	Average Daily Dose
ADEC	Alaska Department of Environmental Conservation
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AKA	Also Known As
AOC	Area(s) of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society of Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	All Terrain Vehicle
BCF	Bioconcentration Factor
BGS	Below Ground Surface
BTF	Biotransfer Factor
CDLT	Contractor Data Loading Tool
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CWA	Clean Water Act
DO	Dissolved Oxygen
DOD	Department of Defense
DQOs	Data Quality Objectives
DRO	Diesel Range Organics
DTIC	Defense Technical Information Center
EF	Exposure Frequency
EPC	Estimated Point Concentration

FSP	Field Sampling Plan
GRO	Gasoline Range Organics
HEAST	Health Effects Assessment Summary Tables
HQ	Hazard Quotient
HSDB	Hazardous Substance Database
ID	Internal Diameter
IF	Intake Factor
IRA	Interim Remedial Action
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
ITIR	Informal Technical Information Report
JSS	Joint Surveillance System
LOEL	Lowest Observed Effect Level
LRRS	Long Range Radar Station
MAR	Minimally Attended Radar
MF	Modifying Factor
MSL	Mean Sea Level
NAB	Northwest Arctic Borough
NCP	National Contingency Plan
NIR	Normalized Ingestion Rate
NMFS	National Marine Fisheries Service
NOEL	No Observed Effect Level
NORAD	North American Air Defense Command
NTIS	National Technical Information Center
PCBs	Polychlorinated biphenyls
PE	Performance Evaluation
PEF	Particulate Emission Factor
PID	Photoionization Detector
POL	Petroleum, Oil, Lubricants
PQL	Practical Quantitation Limit

QA/QC	Quality Assurance/Quality Control
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBC	Risk-based Screening Concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Level of Exposure
ROCC	Region Operations Control Center
RRO	Residual Range Organics
RPD	Relative Percent Differences
RTECS	Registry of Toxic Effects of Chemical Substances
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SCF	Stem Concentration Factor
SCS	Site Characterization Summary
SF	Slope Factor
SOP	Standard Operating Procedure
SVOC	Semivolatile Organic Compounds
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
U.S. EPA	United States Environmental Protection Agency
UCL	Upper Confidence Limit
UF	Uncertainty Factor
USAF	United States Air Force
USCS	Unified Soil Classification System
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VF	Volatilization Factor
VOC	Volatile Organic Compounds
Vp	Volatilization Potential

WACS	White Alice Communications System
WP	Work Plan
WQS	Water Quality Standards (AK)

EXECUTIVE SUMMARY

The United States Department of the Air Force (USAF) has conducted a remedial investigation/feasibility study (RI/FS) at the Kotzebue Long Range Radar Station (LRRS), Kotzebue, Alaska. This Baseline Risk Assessment Report was prepared as part of the RI/FS. This report is intended to provide a quantitative assessment of the risk to humans and to ecological receptors from exposure to contaminants measured in soil, sediment, surface water, and groundwater during the RI at the Kotzebue LRRS conducted in 1994 (USAF 1995a). The risks enumerated in this report are based upon two types of data: 1) actual measurements of contaminants in the sampled media, and 2) extrapolated estimates of contaminant concentrations into media which were not part of the sampling design, including: air, plants, and land and marine mammals. Extrapolated concentrations were based upon actual detected concentrations in either soil or water at the Kotzebue LRRS site and were based on conservative exposure assumptions. The conclusions reached in this report should be protective of potential human and ecological receptors in the Kotzebue area because of the conservative assumptions and estimates used in performing this baseline risk assessment.

Contaminants evaluated included volatile and semi-volatile organic compounds, including: benzene, a number of phenolic compounds, naphthalenes, and polycyclic aromatic hydrocarbons. Additionally, other contaminants at the Kotzebue LRRS site included DDT residues, derived from suspected use of this insecticide for mosquito control, and polychlorinated biphenyls (PCBs), derived from spilled transformer fluids. Samples obtained during the RI were analyzed for total petroleum hydrocarbons (TPH) (residual, diesel and gasoline ranges), volatile and semi-volatile organic compounds, pesticides, PCBs, and metals, although not all analytes were analyzed for every sample.

Due to the size and complexity (i.e., number and size of contaminated areas, drainage patterns, potential exposure pathways) of the Kotzebue LRRS site, the installation was divided into four separate investigative areas, each of which was evaluated independently. By dividing the Kotzebue LRRS site into areas, the focus and the size of the contaminated area which may pose a potential risk and require remediation,

could potentially be reduced. The four investigative areas were the White Alice area, Western Drainage, Eastern Drainage, and the Beach area. For the human health assessment, a single risk estimate for each of the four areas was obtained by pooling data for all of the exposure pathways.

Five main steps were conducted as part of the risk assessment process, one of which (ecological characterization) was only performed for the ecological risk assessment:

1. ***Data Collection and Evaluation***

The data collected and evaluated for this baseline risk assessment were obtained from the RI sampling efforts conducted during the summer of 1994. There are several factors to consider in assessing the useability of environmental data in baseline risk assessments (U.S. EPA 1989), including: data quality objectives, source, documentation, analytical methods/detection limits, and level of review. A review of these factors indicated that the analytical data collected during the 1994 RI were suitable for conducting the baseline risk assessment.

A screening of the contaminant results was performed to determine which chemicals might pose a potential risk to humans or ecological receptors. The screening consisted of the following four steps: 1) compare maximum detected concentration for each chemical in each medium with risk-based screening concentrations (RBCs) for human health risk assessment or with water and sediment quality guidelines/criteria for ecological risk assessment, 2) compare maximum practical quantitation limits (PQLs) to RBCs or guidelines/criteria for chemicals which were not detected, 3) identify organic chemicals which were detected but for which no RBCs or guidelines/criteria are available, and 4) compare maximum concentrations to mean background concentrations for metals without RBCs or guidelines/criteria. Upon completion of these four steps, a list of chemicals of potential concern (COPCs) was generated for the human health risk assessment and a list of chemicals of potential ecological concern (COPECs) was generated for the ecological risk assessment.

For the human health risk assessment, a total of 89 COPCs were identified using the approach described above. Within each of the four media, the number of COPCs ranged from 45 for sediment to 71 for groundwater. The majority of the COPCs were never detected above the PQLs at Kotzebue LRRS. For the ecological risk assessment, a total of 67 COPECs were identified.

Within each of the four media, the number of COPECs ranged from 28 for sediment to 41 for soil. Approximately one-half of the COPECs were never detected above the PQLs at Kotzebue LRRS.

The reasonable maximum exposure (RME) scenario was chosen as a conservative approach whereby the exposure point concentration (EPC) that a particular individual (human or animal) is likely to be exposed to is defined as the 95 percent upper confidence limit (UCL) of the available sampling data for each investigative area/medium combination [U.S. Environmental Protection Agency (EPA) 1991c]. In cases where the 95 UCL exceeds the maximum concentration, which is possible given a highly variable group of data points, the maximum concentration was used for the EPC.

2. ***Ecological Characterization***

For the ecological risk assessment, the abundance and distribution of species in the vicinity of Kotzebue was described so that key receptor species could be identified. The criteria for the selection of key species included: 1) abundance and frequency of residence at Kotzebue LRRS, 2) importance in the ecosystem, 3) availability of toxicity data for similar species, and 4) importance for recreational/subsistence activities of Kotzebue residents. Based on these criteria, the key receptor species for the ecological risk assessment were ringed seal from the marine environment and Arctic ground squirrel and caribou from the terrestrial environment.

3. ***Exposure Assessment***

Potential exposure pathways were evaluated and complete pathways were selected for quantitative evaluation.

Human Health Risk Assessment

Potential human receptors evaluated for exposure to contaminants at the Kotzebue LRRS site included: the USAF personnel and radar maintenance technicians who service the installation on a periodic basis; recreational users who use all terrain vehicles on roads and beach areas, beach comb, picnic along the beach, and recreationally hunt and fish; and subsistence users who pick berries in adjacent wetlands, hunt along the tundra hill and surrounding area, and hunt marine

mammals and fish in Kotzebue Sound and along the beach area. Additionally, adults and children were evaluated separately as potentially exposed populations.

There are several pathways for a human receptor to be exposed to contaminants, depending upon the contact media. Pathways evaluated in this baseline risk assessment included (by media):

- | | |
|----------------------|---|
| ■ Soil | Ingestion, Dermal Contact, and Inhalation of dust |
| ■ Surface Water | Ingestion and Dermal Contact |
| ■ Sediment | Ingestion and Dermal Contact |
| ■ Plants and Animals | Ingestion |
| ■ Air | Inhalation (via volatilization) |

Ingestion and dermal contact with groundwater were considered to be incomplete pathways and were not evaluated further. Figure ES-1 is a schematic diagram demonstrating the potential release mechanisms, exposure pathways, and human receptors at the Kotzebue LRRS site.

Ecological Risk Assessment

For ringed seals, the dietary exposure pathway (consumption of fish) is likely to be the only significant route of exposure. Two other potential routes of exposure, ingestion of water and dermal contact, were considered to be incomplete and were not evaluated further. For ground squirrels and caribou, the dietary pathway (consumption of plants) and the drinking pathway were considered. Ingestion of soil was considered for ground squirrels, but not for caribou because these animals are browsers and do not typically include any soil in their diet (Boertje 1990, Crête et al. 1990). Two other potential exposure routes, dermal contact and inhalation, were not considered for ground squirrels or caribou because of the lack of dermal toxicity and respiratory physiology data. Figure ES-2 is a schematic diagram demonstrating the potential release mechanisms, exposure pathways, and ecological receptors at the Kotzebue LRRS site.

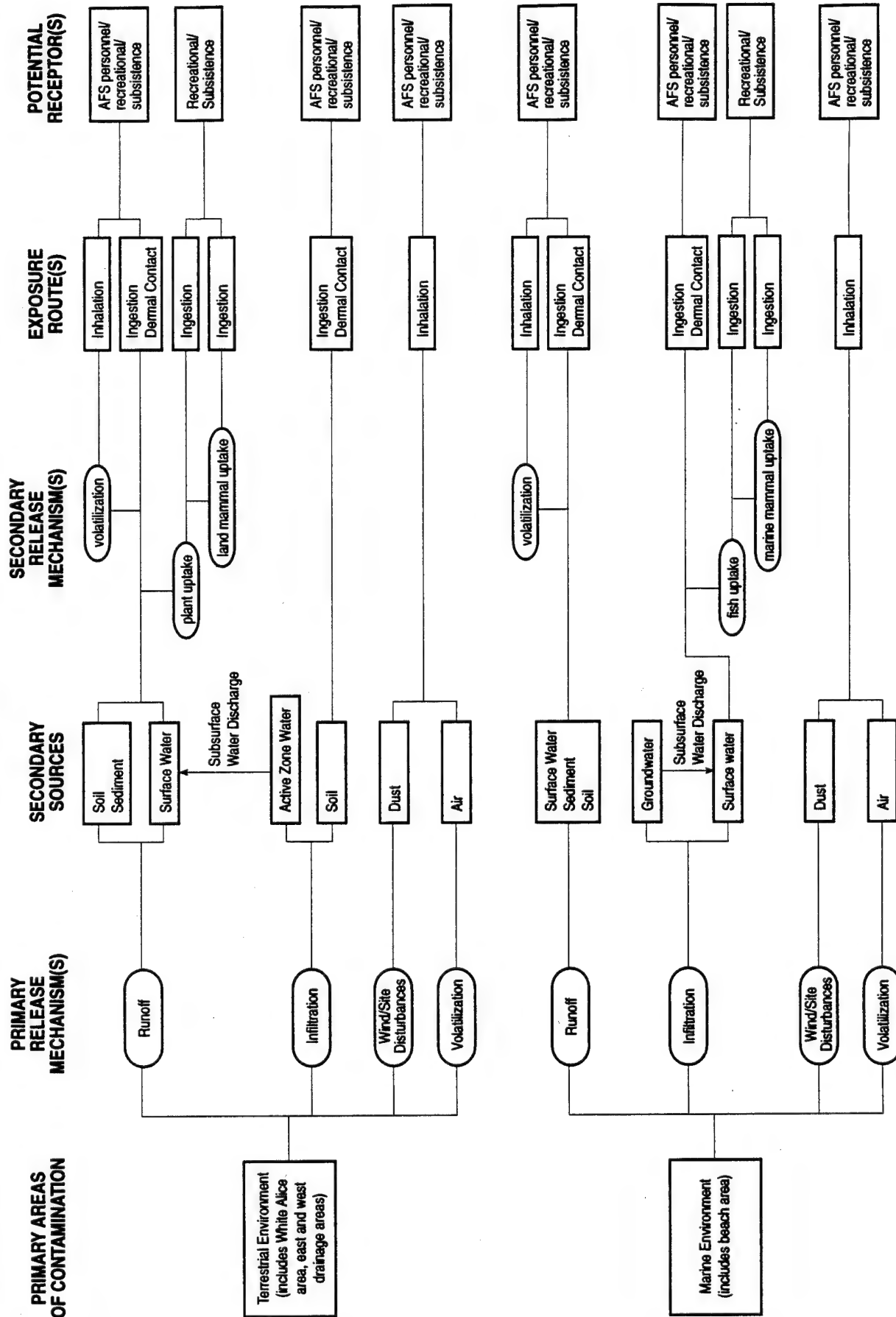


Figure ES-1. Human Health Exposure Pathways Evaluated for Kotzebue LRRS, Alaska.

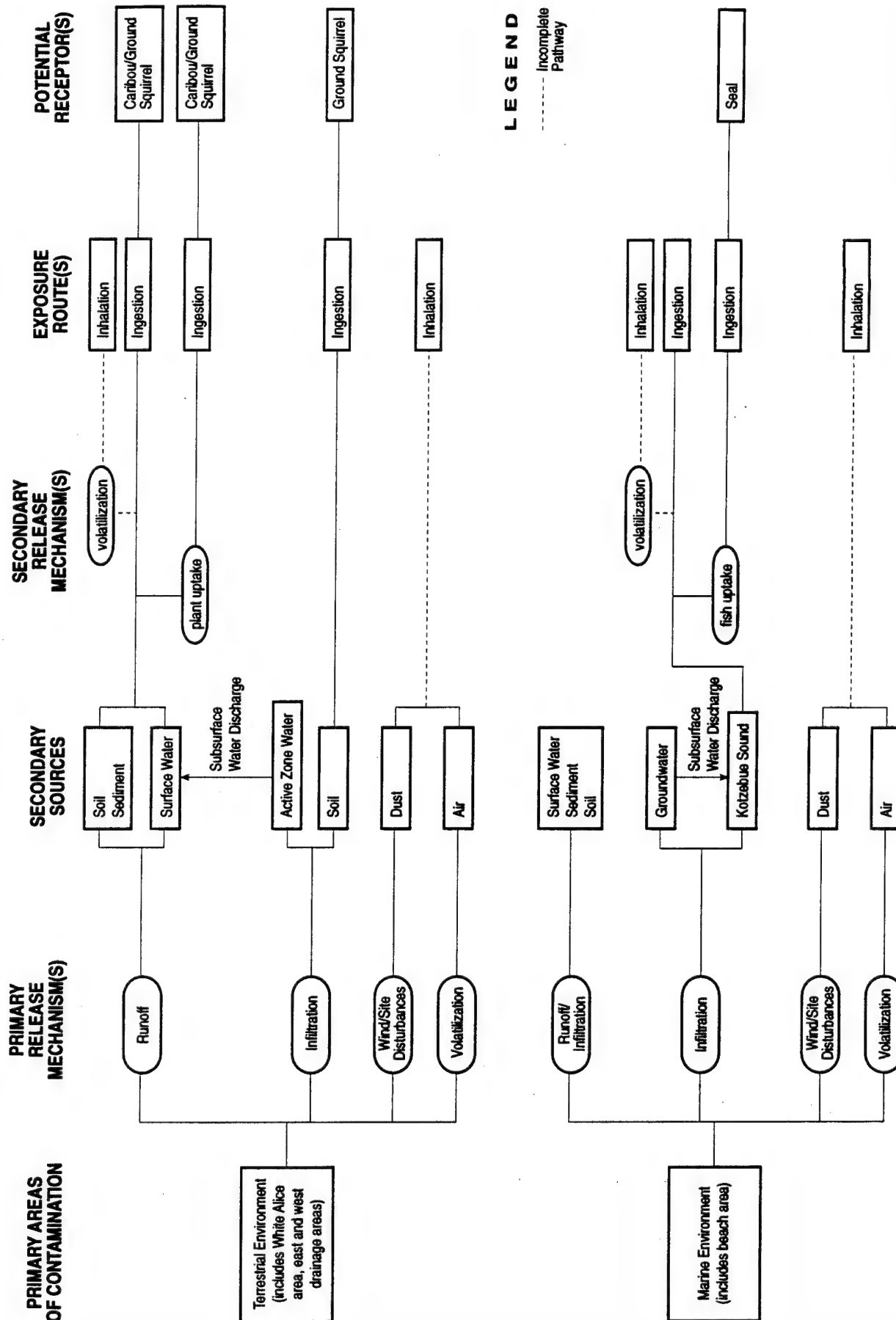


Figure ES-2. Ecological Exposure Pathways Evaluated for Kotzebue LRRS, Alaska.

4. *Toxicity Assessment*

For the COPCs and COPECs, toxicity data were collected and compared to the measured concentrations at Kotzebue LRRS.

Human Health Risk Assessment

The adverse health effects of the chemicals of potential concern were evaluated using the most current toxicological information provided by the U.S. EPA Integrated Risk Information Systems (IRIS), the Health Effects Assessment Summary Tables (HEAST), or by chemical specific toxicological profiles from the Agency for Toxic Substances and Disease Registry (ATSDR). Carcinogenic chemicals, classified by the U.S. EPA according to the weight of evidence from epidemiologic and animal studies, characteristically have no threshold value. For those chemicals with carcinogenic evidence, chemical specific cancer slope factors (SF), defined as the upper bound estimate for potential carcinogenic risk, were used in this evaluation. Chemical specific reference doses (RfD), defined as an estimate for daily human exposure that is likely to be without appreciable risk of deleterious effects and derived from epidemiologic and animal studies, were used in the evaluation of non-carcinogenic chemicals.

Ecological Risk Assessment

Toxicity assessment includes the definition of both assessment and measurement endpoints. For the key receptor species, the assessment endpoints were the continued existence of healthy, viable populations in the vicinity of Kotzebue. The measurement endpoints are manifested at the level of the individual. Specifically, the measurement endpoints for this project represent the lowest published [Registry of Toxic Effects of Chemical Substances (RTECS) or HEAST 1994] chronic dose, if available, associated with no adverse effects to the target mammal species for a given COPEC. Uncertainty factors (UFs) were applied to account for inter-species differences in the response to a toxic chemical and to account for the differences in endpoints for the reported dose (e.g., lethal vs. non-lethal, chronic vs. acute).

5. ***Risk Characterization***

Risk characterization is a process by which the estimates made during the exposure assessment are compared to the data gathered during the toxicity assessment to determine if there is a potential for significant risk for a particular exposure pathway or chemical. Chemicals that were detected were evaluated separately from chemicals that were not detected above the PQL.

Human Health Risk Assessment

Carcinogenic risks were evaluated on the basis of their calculated risk estimates. Typically, an excess individual lifetime cancer risk of 10^{-6} (1.0E-6) is used by the U.S. EPA as a benchmark when determining whether chemical exposures represent a potentially unacceptable level of risk to public health. According to the revised National Contingency Plan (NCP) (U.S. EPA 1990c), carcinogenic risks from exposure at Superfund sites are considered to be unacceptable at a level greater than 10^{-4} (1.0E-4), while risks smaller than 10^{-6} are considered to be of minimal concern. For the purposes of this risk assessment, an excess individual lifetime cancer risk of 10^{-6} (1.0E-6) was used to assess the degree of impact to public health from the contamination at Kotzebue LRRS.

Non-carcinogenic risks were evaluated on the basis of their calculated hazard quotient (HQ) which is accepted by the U.S. EPA as a way to quantify levels of risk for non-carcinogens. A HQ value greater than one indicates that an adverse health effect may occur due to a chemical exposure.

Ecological Risk Assessment

Ecological risk was characterized by the quotient method, where risk is assumed to increase with the magnitude of the quotient exposure dose/reference dose. For hazard quotients (HQs) of less than 1, an assumption is made that the risk from that particular combination of COPEC, investigative area, species, and exposure route is not significant. For HQs greater than 1, there is an indication that the risk could be significant.

6. *Summary of Results*

The results of the human health and ecological baseline risk assessments were summarized by identifying the chemicals, exposure pathways, and areas of greatest concern.

Human Health Risk Assessment

Several of the exposure pathways evaluated at Kotzebue LRRS show the potential for some risk to humans, as indicated by total carcinogenic risk estimates of greater than $1.0\text{E-}6$ or total HQ estimates of greater than 1 for detected COPCs. These pathways include inhalation of dust; ingestion of soil and sediment; dermal contact with soil, sediment, and surface water; and ingestion of berries. No potential risk was indicated from other dietary pathways such as ingestion of water, fish, seal, or caribou.

Table ES-1 shows the sum of the risk estimates calculated for all exposure pathways evaluated at each of the four investigative areas. For detected carcinogenic COPCs, the total risk ranged from $4.63\text{E-}6$ at the Beach area to $6.41\text{E-}5$ at the West Drainage area for adults, and from $8.11\text{E-}6$ at the Beach area to $4.65\text{E-}5$ at the West Drainage area for children. For detected non-carcinogenic COPCs, the total risk at the Beach area was again the lowest of the four areas (0.026 and 0.176 for adults and children, respectively), while the highest total risk was at the East Drainage area (5.13 and 21.8 for adults and children, respectively). The total risk from non-detected COPCs was approximately 100 times greater than the total risk from detected COPCs.

A total of 36 detected COPCs were evaluated for the human health baseline risk assessment. Of this total, five chemicals (arsenic, Aroclor 1260, heptachlor epoxide, beta-BHC, and 2-nitroaniline) were detected at concentrations that resulted in risk estimates exceeding a cancer risk of $1.0\text{E-}6$ or a non-cancer risk of 1 for a particular exposure pathway. The locations of the individual samples that exceeded risk-based screening levels for these COPCs are shown in Table ES-2.

Ecological Risk Assessment

The only exposure pathway for which the estimated total HQ value was greater than 1 was the dietary pathway for both caribou and ground squirrels. Based on the results from the evaluation of the dietary exposure route, the ground squirrel is a more sensitive ecological receptor at Kotzebue LRRS than the caribou. No significant risk to ecological receptors was indicated for

**TABLE ES-1. SUMMARY OF COMBINED RISK ESTIMATES FOR
ALL EXPOSURE PATHWAYS FOR EACH INVESTIGATIVE AREA**

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
Beach Area	4.63E-6	0.026	8.11E-6	0.176
White Alice Area	3.57E-5	0.32	3.45E-5	0.707
East Drainage Area	4.20E-5	5.13	2.61E-5	21.8
West Drainage Area	6.41E-5	1.93	4.65E-5	3.98
NON-DETECTED COPCs				
Beach Area	3.61E-4	8.18	5.68E-4	26.6
White Alice Area	2.37E-3	18.9	3.19E-3	71.2
East Drainage Area	1.25E-3	15.3	1.43E-3	54.8
West Drainage Area	1.46E-3	14.2	1.76E-3	49.2

**TABLE ES-2. LOCATION OF COPCs WHICH EXCEED A 10^{-6} RISK VALUE
OR A HQ OF 1 AT KOTZEBUE LRRS**

Contaminant	Exposure Pathway			
	Soil/Sediment Ingestion	Dermal Contact	Berry Ingestion	Inhalation
2-Nitroaniline			SS08	
Arochlor 1260	SS11, AOC8	AOC8, SS11, SS12, SS1, SS4		
Arsenic	SS16, SS07, SD3, SD4, SS15, AOC7, AOC8, SS13, SS18, SS02, SS08, SS1, SS3, SS4			SS16, SS07, SD3, SD4, SS15, AOC7, AOC8, SS13, SS18, SS02, SS08, SS1, SS3, SS4
Heptachlor epoxide		SS07, SS11, SS12		
beta-BHC		SS11		

dietary exposure route for ringed seals, water ingestion for caribou or ground squirrels, or soil ingestion for ground squirrels.

A total of 48 detected COPECs were evaluated in this baseline risk assessment. Of this total, three chemicals (total xylenes, 2-methylnaphthalene, and 4-nitrophenol) were detected at concentrations for which potentially significant risk ($HQ > 1$) to caribou or ground squirrels was indicated for the dietary pathway. The specific locations of samples for which the detected concentrations of total xylenes, 2-methylnaphthalene, and 4-nitrophenol in soil exceeded an estimated HQ of 1 for ground squirrels or caribou in the dietary exposure route are shown in Figure ES-3.

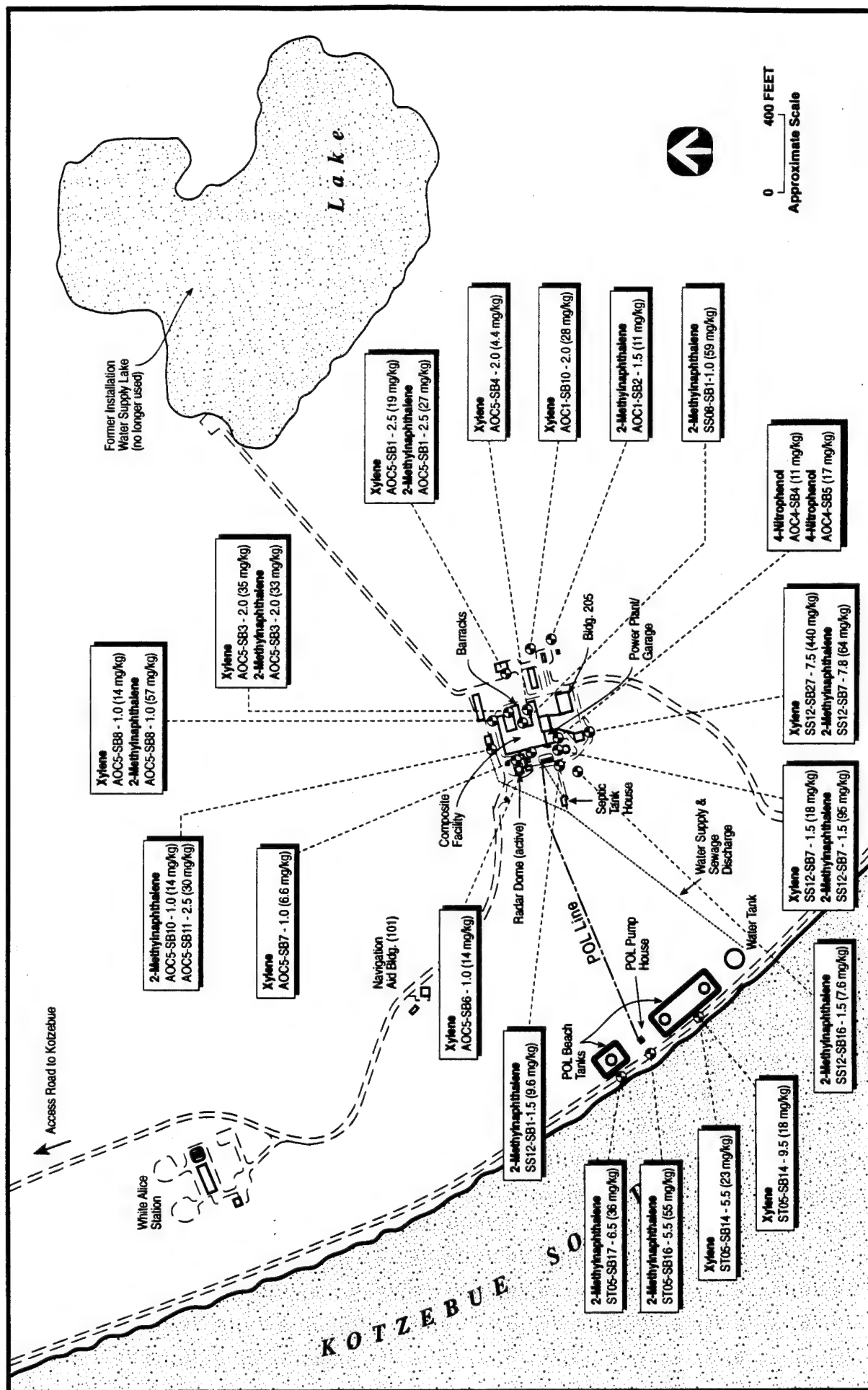


Figure ES-3. Locations of Samples For Which Concentrations of Xylenes, 2-Methylnaphthalene, and 4-Nitrophenol in Soil Exceeded Hazard Quotient of One for Ground Squirrels in Dietary Pathway, Kotzebue LRRS, Alaska.

1.0 INTRODUCTION

The United States Department of the Air Force (USAF) has conducted a remedial investigation/feasibility study (RI/FS) at the Kotzebue Long Range Radar Station (LRRS), Kotzebue, Alaska. The RI/FS was conducted under the authority of the USAF Installation Restoration Program (IRP) and under direction of the Air Force Center for Environmental Excellence (AFCEE). Requirements of the IRP were developed to ensure Department of Defense (DOD) compliance with federal laws such as the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and Superfund Amendments and Reauthorization Act (SARA).

The Kotzebue LRRS installation is located 26 miles north of the Arctic Circle, approximately 610 miles northwest of Anchorage and 450 miles west-northwest of Fairbanks, Alaska (Figure 1-1). The installation occupies 676 acres of land adjacent to Kotzebue Sound on the Baldwin Peninsula within the Kobuk-Selawik Lowland section of Coastal Central Alaska (Figure 1-2). The LRRS installation, in operation since 1950, operated as a ground-controlled intercept site until 1973, when it was converted to a North American Air Defense Command (NORAD) surveillance station. In 1982, installation of Joint Surveillance System (JSS) equipment enabled radar and beacon data to be transmitted by satellite to the Elmendorf Region Operations Control Center (ROCC), thereby decreasing the number of personnel employed at the site. A Minimally Attended Radar (MAR) system, installed in 1985, enabled deactivation of the site, with the exception of the radome. A single maintenance technician who services the active radar dome is currently housed in the nearby City of Kotzebue (USAF 1990a). Additional personnel provide maintenance on an as-needed basis. Figure 1-3 provides an illustration of the Kotzebue LRRS facility.

Past operations such as radar and vehicle shop maintenance at Kotzebue LRRS generated wastes, including waste oils and spent solvents (USAF 1990a). Some waste oils were used for ground application (dust control) on roads. A waste accumulation area and installation landfill, both located adjacent to Kotzebue Sound, were used to store and dispose of facility wastes. Potential contaminants associated with

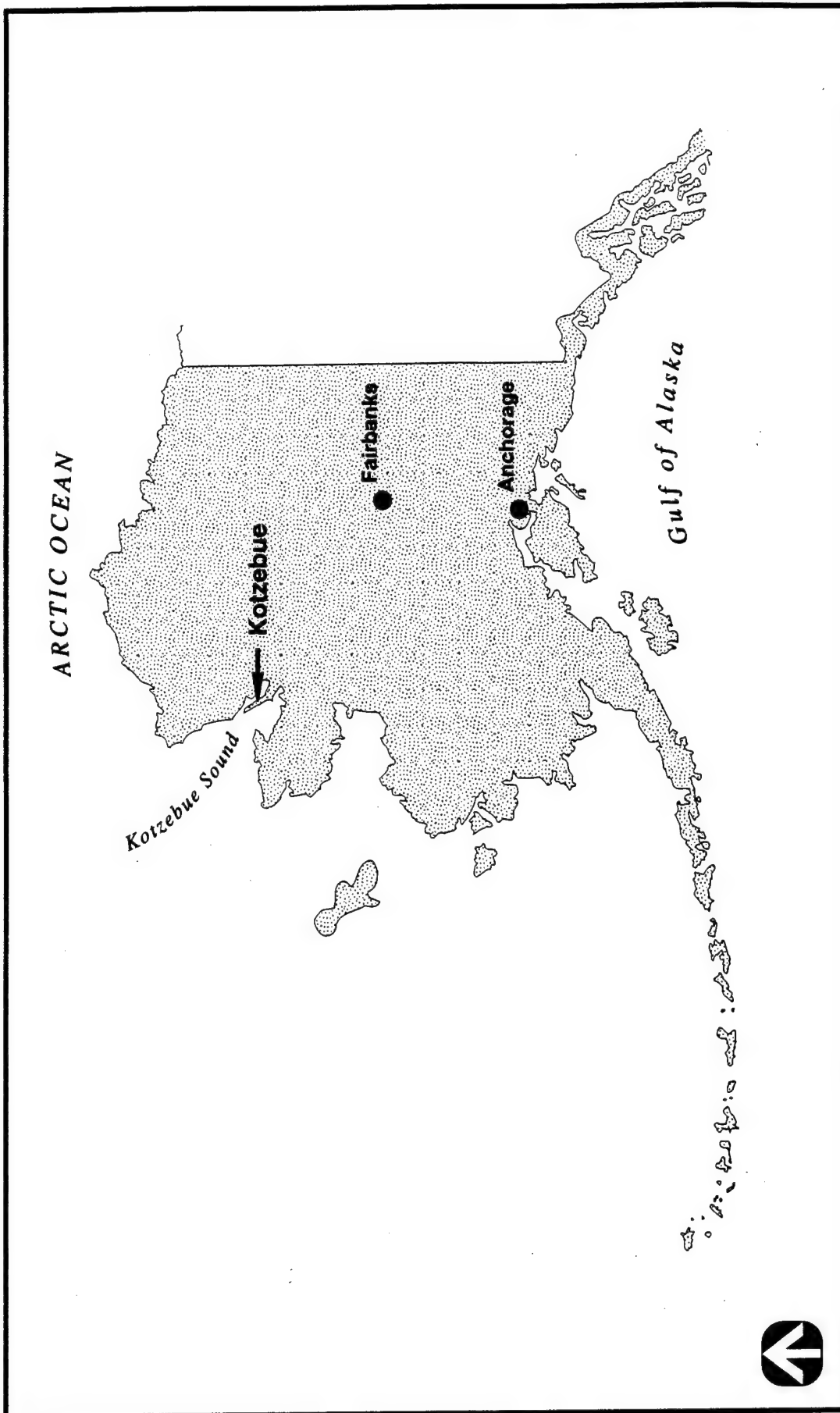


Figure 1-1. Location of Kotzebue, Alaska.

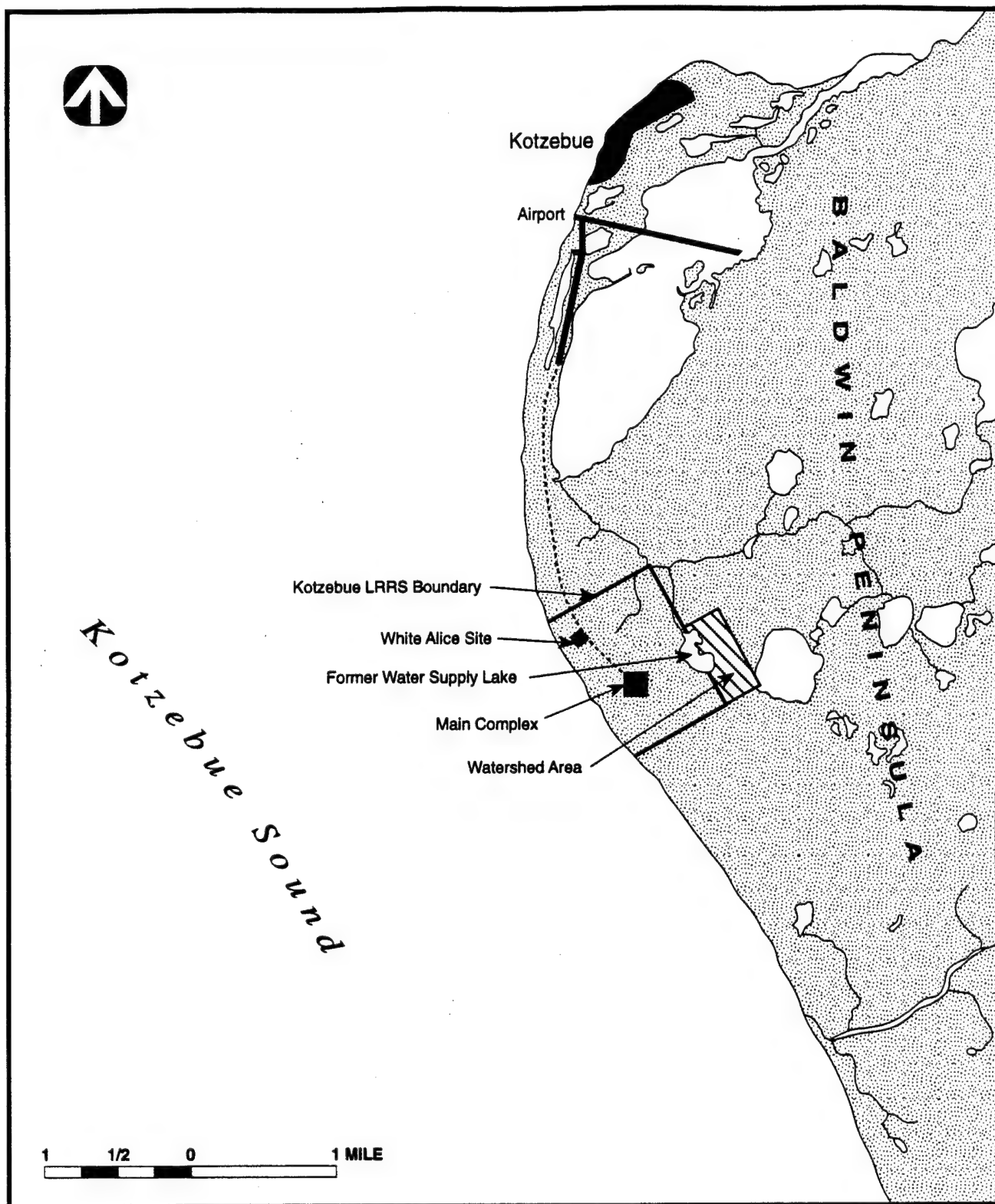


Figure 1-2. Location of the Kotzebue Long Range Radar Station (LRRS), Alaska.

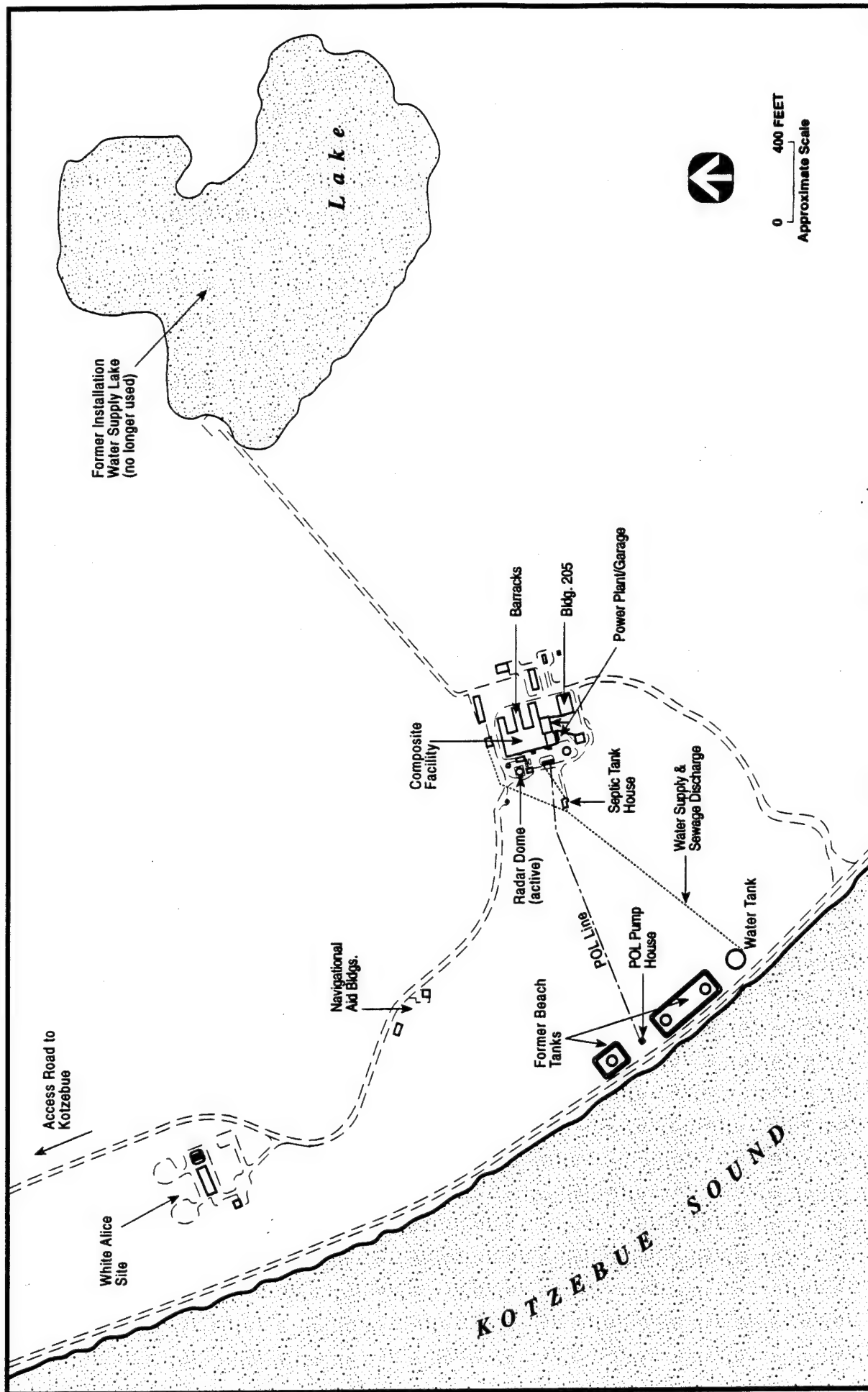


Figure 1-3. Facility Locations at Kotzebue LRRS, Alaska.

base operations include waste oil, fuels, solvents, herbicides, and pesticides. In 1972, the waste accumulation area was closed, and in 1974 the landfill was closed. The waste accumulation area and landfill were cleaned and regraded, and drummed wastes were removed from the installation in 1975. Fuel management at Kotzebue LRRS resulted in leaks and spills. Diesel fuel was stored in large above-ground storage tanks located adjacent to Kotzebue Sound. These tanks provided fuel to smaller fuel tanks located adjacent to the Composite Facility. The beach fuel storage tanks were removed in 1992. The smaller fuel tanks located adjacent to the Composite Facility are still in place, but were inspected and emptied of any residual product in 1993.

This document provides a baseline risk assessment (both human health and ecological) for Kotzebue LRRS. It is intended to provide an assessment of the risk to humans and ecological receptors, respectively, from exposure to contaminants measured during the RI of the Kotzebue LRRS conducted in June-July 1994. The human health and ecological risks enumerated in this report have been estimated from contaminant measurements of soil, surface water, and groundwater (USAF 1995a).

1.1 SCOPE OF HUMAN HEALTH BASELINE RISK ASSESSMENT

The technical approach for this baseline human health risk assessment is consistent with the May 1992 version of the *Handbook to Support the Installation Restoration Program (IRP) Statements of Work, Volume I: Remedial Investigation/Feasibility Studies (RI/FS)* (U.S. Air Force Reprint, 22 May 1992), hereinafter referred to as the *IRP Handbook*; *The Exposure Factors Handbook* [(U.S. Environmental Protection Agency (EPA) 1990a]; *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (U.S. EPA 1989a); *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual - Supplemental Guidance* (U.S. EPA 1991a); and *The Supplemental Guidance for Superfund Risk Assessments in Region X* (U.S. EPA 1991c).

The quantitative human health risk assessment approach developed in this report also provides information that can be used to evaluate the relative risks associated with different remedial alternatives, in the second phase of the feasibility study. The results of the baseline risk assessment may be used to: 1) support a "No Further Action" decision, 2) prioritize the need for remediation at various sites, or 3) provide a basis for the quantification of cleanup objectives.

Four main tasks were conducted as part of the baseline human health risk assessment:

- Data Evaluation
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization.

Each of these tasks is described in greater detail below.

Data evaluation involved the identification of chemicals of potential concern present at the Kotzebue LRRS site and the analysis of other site data relevant to the human health evaluation. Data evaluation activities included:

- Comparison of measured metal values with background concentrations
- Determination of chemicals of potential concern
- Determination of chemical exposure point concentrations.

The purpose of the exposure assessment was to evaluate the site in its current condition to assess the type and magnitude of potential human exposure. This evaluation included: characterization of the setting, identification of potential human receptor populations, determination of potentially complete exposure pathways, and quantification of chemical exposures (intakes) using measured and predicted chemical concentrations.

The toxicity assessment evaluated the potential for chemicals detected at the Kotzebue LRRS site to cause adverse health effects. Chemical-specific toxicity information was obtained from U.S. EPA Integrated Risk Information System (IRIS) (U.S. EPA 1994d), Health Effects Assessment Summary Tables (HEAST) (U.S. EPA 1994c), and Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles.

The risk characterization estimated potential health risks associated with detected contaminants at the Kotzebue LRRS based upon toxicity information and results from the exposure assessment.

1.2 SCOPE OF ECOLOGICAL BASELINE RISK ASSESSMENT

The technical approach for this baseline ecological risk assessment is consistent with the *IRP Handbook; General Guidance for Ecological Risk Assessment at Air Force Installations* (The Mitre Corporation 1990); and according to guidance provided by the U.S. EPA in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. EPA 1988); *Risk Assessment Guidance for Superfund, Volume II-Environmental Evaluation Manual* (U.S. EPA 1989b); and *Framework for Ecological Risk Assessment* (U.S. EPA 1992b).

An ecological risk assessment is defined by the U.S. EPA (1992b) as "a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors." For a risk to exist, the stressor must be capable of causing one or more adverse ecological effects and it must contact or accumulate in an ecological receptor long enough and at a high enough concentration to cause the specified adverse effect. The ecological risk assessment may focus on one or more stressors and biotic components of the potentially affected ecosystem, including interactions among stressors and interactions among biotic ecosystem components. Currently there are no rigid guidelines for the performance of ecological risk assessments, although a general framework for conducting ecological risk assessments has been outlined (U.S. EPA 1989b, 1992b). The scope of an ecological risk assessment can involve qualitative approaches or quantitative approaches involving population or ecosystem modeling and/or the modeling of chemical fate, transport, and accumulation in organisms. The scope of the Kotzebue LRRS baseline ecological risk assessment was to conduct a baseline assessment of the ecological risks to important biological resources in the vicinity of the Kotzebue LRRS associated with existing levels of contaminants identified during the RI conducted in June-July 1994.

The baseline ecological risk assessment involved five general tasks:

- *Data Evaluation and Stressor Characterization*--Identify, quantify, and validate the concentrations of chemicals of potential concern and characterize their sources
- *Ecological Characterization*--Characterize biological resources potentially affected by the stressors.

- *Toxicity Assessment*--Identify appropriate ecological toxicity assessment endpoints and the concentrations of contaminants that will cause an adverse effect.
- *Exposure Assessment*--Measure or estimate the exposure concentrations that contact ecological receptors.
- *Risk Characterization*--Combine the information in the previous four tasks to estimate the likelihood that the existing concentrations of contaminants cause adverse effects and assess the uncertainties associated with the risk estimates.

Because of the large number of potential ecological receptors, an additional task is the selection of key receptor species. An investigation and evaluation of marine and terrestrial species and their food web relationships, as well as their economic importance, form the basis for the selection of the key receptor species.

1.3 REPORT ORGANIZATION

Kotzebue LRRS has been the focus of a number of environmental investigations in recent years. Section 2.0 describes the results of the past investigations, as well as the sampling design for the 1994 RI. Section 3.0 provides an overview of the environmental setting and the relevant characteristics of the marine and terrestrial biological communities. Section 4.0 presents a data evaluation for the 1994 RI. The baseline risk assessments are presented in Sections 5.0 (human health) and 6.0 (ecological). Each of these sections includes subsections for each of the major technical approach tasks. Section 7.0 provides the references cited in this document.

2.0 PAST AND PRESENT IRP ACTIVITIES

2.1 PAST IRP ACTIVITIES

Several previous investigations have been conducted at Kotzebue LRRS, including a Phase I records search, Phase I and Phase II RI/FS programs, beach tank removals, an environmental baseline survey of Navigational Aid Building 101, and site surveys in 1993 and 1994.

2.1.1 Phase I Records Search

In 1985, a Phase I Records Search was conducted for the Alaskan Air Command Northern Region, which includes Kotzebue LRRS. The purpose of the Phase I records search was to identify and prioritize past disposal sites that may pose a hazard to public health or the environment as a result of contaminant migration to surface water or groundwater, and to identify contaminants that could have an adverse effect due to their persistence in the environment. Twelve sites were identified from a review of base records, interviews with current and former employees, information gathered during field surveys, and from interviews with local, state, and federal agency representatives. Based on an additional assessment of factors such as site characteristics, waste characteristics, and the potential for contaminant migration, eight sites were identified for further IRP evaluation (USAF 1985).

2.1.2 Stage 1 RI/FS

In 1988, a Stage 1 RI/FS was conducted at Kotzebue LRRS to assess past disposal and spills of hazardous materials, and to develop remedial actions for sites thought to pose a threat to human health or the environment. Twelve sites were identified for investigation (Table 2-1). These sites included the eight sites identified for further IRP evaluation during the Phase I Records Search. Based on a 1987 field reconnaissance effort, two of the twelve sites proposed for investigation were dropped because the reconnaissance did not provide evidence of contamination or environmental stress (USAF 1990a). A Stage 1 RI was conducted at the remaining 10 sites. This investigation included soil/sediment sampling at all sites, surface water sampling at site SS07-Lake, a soil gas survey at the SS12-Spills No. 2 and 3

TABLE 2-1. SITE IDENTIFICATION FOR 1988 STAGE 1 RI/FS

USAF Site Designation	Site Name	Site Descriptions
SS01	Waste Accumulation Area No. 1	This site is located south of Building No. 205, west of the installation access road. The site is an approximate 80x160 ft gravel pad formerly used to store drummed waste oils and/or solvents.
SS02	Waste Accumulation Area No. 2 /Landfill	The landfill is located on a triangular piece of land adjacent to and north of the former fuel storage tanks on the beach. Waste accumulation Area No. 2 is located northeast of the former fuel storage tanks adjacent (south) to the landfill. The landfill was used until approximately 1974. Waste accumulation Area No. 2 was used until approximately 1972; in 1975, the site was cleaned up and the area graded.
SD03	Road Oiling	Waste oils, spent solvents, ethylene glycol, and other shop wastes were reportedly used for dust control on the installation road system. The use of waste oil for dust control was practiced until 1984.
ST05	Beach Tanks	The site is located approximately 0.25 miles southwest of the Composite Facility. The site is associated with the former POL (diesel fuel) storage tanks located adjacent to Kozebue Sound and comprises an area of approximately 250x900 ft.
SS06	Spill No. 1	The site is located near the officers wing of Building 103 (northern most wing). A diesel fuel leak reportedly occurred in a fuel line in the mid-1970's due to a coupling failure.
SS07	Lake	The lake is located approximately 0.25 miles northeast of the Composite Facility. The lake served as the installation drinking water supply until 1985.
SS08	Barracks Pad	The site is located adjacent to the Composite Facility, between two building wings. The site is an approximate 25 x 40 ft gravel pad reportedly used to store chemicals such as solvents, rust inhibitors, chlorobromomethane, and various fluorocarbons. Small above ground diesel fuel tanks located adjacent to the barracks pad are reportedly a potential source of diesel fuel contamination.
SS09	PCB Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A PCB spill reportedly occurred on a portion of a 10 x 10 ft gravel pad.
SS10	Solvent Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A solvent spill had reportedly occurred covering an approximate 10 x 20 ft area on the edge of a gravel pad.
SS11	Fuel Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A jet fuel spill reportedly occurred which covered an approximate 50 x 60 ft area.
SS12	Spill No. 2	The site is located west-southwest of the Composite Facility power plant. A diesel fuel spill reportedly occurred in 1979-1980 when the day tank behind the power plant was overfilled.
SS12	Spill No. 3	The site consists of an approximate 1.5 acre area adjacent to, and west-southwest of, the Composite Facility. A large diesel fuel leak reportedly occurred via a hole in a distribution line identified in 1984. The fuel line was repaired, and approximately 4,000 gal of diesel fuel was reportedly collected in recovery trenches subsequently installed by the Air Force.
USAF Stage 1 RI/FS (USAF 1990a)		

sites, water-flooding pilot testing at the SS12-Spill No. 3 site, and aeration of soils at the SS11-Fuel Spill site (USAF 1990a). Identified contaminants included petroleum hydrocarbons, polychlorinated biphenyls (PCBs), delta-BHC, 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD. A qualitative ecological and human health risk screening approach was developed to identify sites warranting further consideration for possible remedial actions. This screening approach did not identify any sites that posed substantial ecological or human health risks (USAF 1990a). Despite these findings, several sites were recommended for further remedial action based on soil analyses indicating contamination above recommended cleanup levels. The sites recommended for further activity were SS12-Spill No. 2, SS12-Spill No. 3, SS01-Waste Accumulation Area No. 1, SS09-PCB Spill, SS10-Solvent Spill, SS11-Fuel Spill, and ST05-Beach Tanks sites.

2.1.3 Stage 2 RI/FS

In 1989-1990, a Stage 2 RI/FS was conducted at Kotzebue LRRS to evaluate the sites recommended for further remedial action. Field activities included an investigation of soil and groundwater at the ST05-Beach Tanks site; pilot-scale remediation tests involving excavation and landfarming; *in situ* enhanced bioremediation; excavation and off-site disposal of PCB contaminated soils; and removal of four transformers (USAF 1990b). Soil and groundwater at the ST05-Beach Tanks site were characterized to quantify the nature and magnitude of contamination at this site, delineate the horizontal and vertical extent of contamination, determine the hydrogeologic setting, and complete a feasibility study of remedial alternatives.

Chemical substances identified in soil and groundwater samples from the ST05-Beach Tanks site included 2-methylnaphthalene, toluene, total xylenes, ethylbenzene, and petroleum hydrocarbons. The qualitative risk screening method developed during the Stage 1 RI/FS was used to assess potential health and environmental risks at the site. The Stage 2 RI/FS concluded that petroleum hydrocarbons at the ST05-Beach Tanks site posed a potentially significant risk to aquatic organisms (USAF 1990b).

2.1.4 Beach Tank Removals

Three diesel fuel storage tanks were located approximately 0.25 miles southwest of the Composite Facility, adjacent to Kotzebue Sound. Two of the tanks were 50 ft in diameter and 22 ft high, each with a storage capacity of 7,890 barrels. The third tank measured 44 ft in diameter and 24 ft high, with a storage capacity of 6,500 barrels (USAF 1990b). Approximately 39,500 gallons of diesel fuel was estimated to remain in the three storage tanks. In 1992, the USAF removed the fuel and the three storage

tanks from the site. Remaining accessory structures included the bermed containment areas, asphalt tank pads within the bermed areas, and a fuel pump house.

2.1.5 Environmental Baseline Survey (Navigational Aid Building 101)

In July 1993, an environmental baseline survey was conducted at the Navigational Aid Building 101 (see Figure 1-3). The environmental baseline survey was conducted for the University of Alaska, Fairbanks Facility Planning and Project Services Department as a requirement for USAF's long-term lease of this facility. The environmental baseline survey included the collection of eight building material samples for asbestos and four hand-augered soil samples for diesel-range organics (DRO) analysis.

This survey identified asbestos in siding panels on the exterior walls and floor of Navigation Aid Building 101, and in the interior wall wainscoting (Shannon and Wilson, Inc. 1993). Concentrations of DROs measured in this survey ranged from 70 to 4,200 mg/kg.

This survey concluded that spillage or overflow from the fuel delivery system to the generator and diesel furnace in Navigational Aid Building 101 most likely resulted in soil contamination in the immediate vicinity of the tanks, and along the fuel pipeline corridor connecting the above-ground fuel tanks with the building (Shannon and Wilson, Inc. 1993).

2.1.6 1993/1994 Site Survey

On 29 September 1993, a site survey was conducted at Kotzebue LRRS and the surrounding area. The site survey was conducted to evaluate current site conditions, identify potential areas of concern, and obtain information necessary to prepare RI/FS scoping documents for future field activities. Based on the 1993 Site Survey and subsequent discussions, ten additional areas of concern (AOC) were identified for consideration (Table 2-2).

In June 1994, another site reconnaissance was conducted at Kotzebue LRRS. This reconnaissance identified two additional areas of concern for investigation:

TABLE 2-2. 1993 SITE SURVEY AREAS OF CONCERN

Site Designation	Site Name	Site Description
AOC-1	Landfarm	During the Stage 2 RI/FS approximately 500 yd ³ of TPH contaminated soils were excavated from Spills No. 2 & 3 and Waste Accumulation Area No. 1 sites and stockpiled east of the access road, directly across from the Composite Facility. Landfarm activities were conducted to reduce TPH concentrations in affected soil throughout the Stage 2 RI/FS. During the 1993 site survey the landfarm was observed to be in poor condition, with no cover to reduce seasonal infiltration and runoff.
AOC-2	POL Line	Previous investigations at Kotzebue LRRS have not included assessment of the fuel line that transferred fuel from the POL (diesel) fuel tanks, formerly located on the beach, to the main facility.
AOC-3	East Tanks	Two above-ground diesel fuel storage tanks, with an estimated capacity of 20,000 gal each, are located on the east side of the access road adjacent to Building 205. The tanks are supported on concrete footings set in a gravel pad, and are contained within a bermed area. The tanks and surrounding area have not been previously assessed, and some limited signs of soil staining directly beneath outlet valves was observed during the 1993 site survey.
AOC-4	Garage/ Power Plant	Stained soils were observed beneath the raised flooring (approx. 4 ft above ground surface) of the power plant and garage area associated with the Composite Facility. It has not been established that floor drains within these areas discharged directly to the ground.
AOC-5	Small Day Tanks	A number of small day tanks (250 gal above ground diesel fuel tanks) were formerly used throughout the installation. Potential diesel fuel releases could have occurred historically due to overfilling or direct release from tanks or tank lines. No previous assessment of these smaller tanks (as a group) has been conducted.
AOC-6	Navigational Aid Bldg. (101-200)	The navigational aid building is located north of the Composite Facility. The navigation aid building and an adjacent associated structure have been included for assessment based on elevated TPH concentrations in soils identified during a 1993 Environmental baseline survey conducted at Building 101. During the 1993 site survey the buildings were locked and not accessible. The surrounding area did not indicate obvious signs of contamination.
AOC-7	Steel Pilings	This site is identified by steel structure pilings (I-Beams) located east of Building 205, on the east side of the installation's access road. Buildings identified during review of historical aerial photographs suggest that this area was a former construction camp site established during initial radar facility construction.
AOC-8	White Alice Garage	The White Alice garage was reportedly used for storing and servicing site vehicles; no identified releases or hazardous materials storage information has been reported. However, this area has not been previously characterized, and has been recommended for assessment based on past usage of the building. During the 1993 site inspection the building was not accessible for interior inspection. Based on visual observations reported, no obvious signs of contamination were identified.
AOC-9	White Alice Tanks	Two diesel fuel storage tanks, with an estimated capacity of 20,000 gal each, are located at the White Alice Station adjacent to Building 1001. The tanks are presently empty, and tank piping has been disconnected. The tanks are contained within a bermed area and are supported above a gravel base by concrete footings. The tanks are a new area of concern based on reports regarding overfilling at outlet valves during previous 611th CEOS site visits. The 1993 site survey revealed some signs of soil staining directly beneath outlet valves, and an open drum under one of the tank valves was half filled with water, and is assumed to have been used to contain fuel spillage during piping disconnection. The tanks appear to be in good condition, with no observable signs of deterioration.
AOC-10	Septic Holding Tank	The primary sewage treatment of domestic wastewater was provided by a single septic tank located west of the composite facility. Septic tank effluent was discharged into Kotzebue Sound through an outfall line. Shop floor drain wastewater was reportedly discharged to septic tank.

- AOC11-Truck Fueling Pad: A truck fueling pad was identified north of the active radar dome, adjacent to the facility access road. The site consists of a gravel pad (approximately 10 ft x 8 ft in area) with fuel delivery system pipes emerging from a concrete form situated atop the gravel pad. Visual and olfactory evidence of petroleum hydrocarbon contamination was noted within the gravel fill material during inspection. Runoff from the site drains to the southwest. Soil staining was observed along the drainage pathway.
- AOC12-Radar Dome Soil Staining: This site is a relatively small (10 ft x 10 ft) but distinct area of stained soils located approximately 30 ft west of the active radar dome. Visual and olfactory evidence of petroleum hydrocarbon contamination was limited to gravel fill materials.

2.2 SITE STATUS IN 1994

Previous IRP investigations identified twelve sites for potential remediation at Kotzebue LRRS. Two sites, Spills No. 2 and 3, were later combined due to the similar nature of contamination (diesel fuel), and because these spills had commingled. Of these 11 sites at Kotzebue LRRS, the USAF recommended that no further action be implemented at eight sites, based on the results of past RIs and remedial actions. The Alaska Department of Environmental Conservation (ADEC) concurred with this recommendation for five of the eight sites, including Sites SS06-Spill/Leak No. 1, SD03-Road Oiling, SS01-Waste Accumulation Area No. 1, SS09-PCB Spill, and SS10-Solvent Spill.

The remaining six initial sites (SS02-Waste Accumulation Area No.2/Landfill; ST05-Beach Tanks; SS07-Lake; SS08-Barracks Pad; SS11-Fuel Spill; SS12-Spills No. 2 and 3) requiring further action, plus the ten areas of concern (AOC1 through AOC10) identified during the September 1993 site survey, and the two areas of concern (AOC11 and AOC12) identified during the 1994 site reconnaissance, totaled 18 sites to be characterized during the 1994 RI. Subsequently, as a result of the Kotzebue LRRS 1994 Remedial Investigation, a number of Areas of Concern were formally designated as sites by the USAF, as identified below:

Original AKA Designation	USAF Site Designation	USAF Site Name
AOC1	SS13	Landfarm
AOC3	SS14	East Tanks
AOC4	SS15	Garage/Power Plant
AOC6	SS16	Navigational Aid Buildings
AOC6	SS17	Building 102
AOC9	ST04	White Alice Tanks
AOC11	SS18	Truck Fill Stand
AOC12	SS19	PCBs Spill, South Fence

One of the areas of concern (AOC6) was divided into two sites (SS16 and SS17). Site SS16 is the Navigational Aid Buildings, while Site SS17-Building 102 is a 72-square foot area of stained soil, located in a gravel driveway at the Navigational Aid Building (Bldg. 102). Site SS17 was formally identified by the USAF based on the detection of PCB during preliminary field screening in 1994. The area of stained soil comprising Site SS17 is included in the 1994 characterization of Site SS16-Navigation Aid Buildings. The locations of the currently designated 14 sites and 5 areas of concern evaluated in this baseline risk assessment are shown in Figure 2-1.

2.3 KOTZEBUE LRRS 1994 REMEDIAL INVESTIGATION

The data collected during the field activities conducted at the 14 Kotzebue LRRS sites and the 5 AOCs during 1994 provide the basis for the baseline risk assessment. A detailed description of specific activities and field tasks can be found in the Field Sampling Plan (FSP) (USAF 1994b). All field investigation activities and associated results are discussed in detail in the Site Characterization Summary (SCS) Informal Technical Information Report (ITIR) (USAF 1995a). A summary of site-specific field activities conducted at Kotzebue LRRS during the 1994 remedial investigation is provided in Table 2-3.

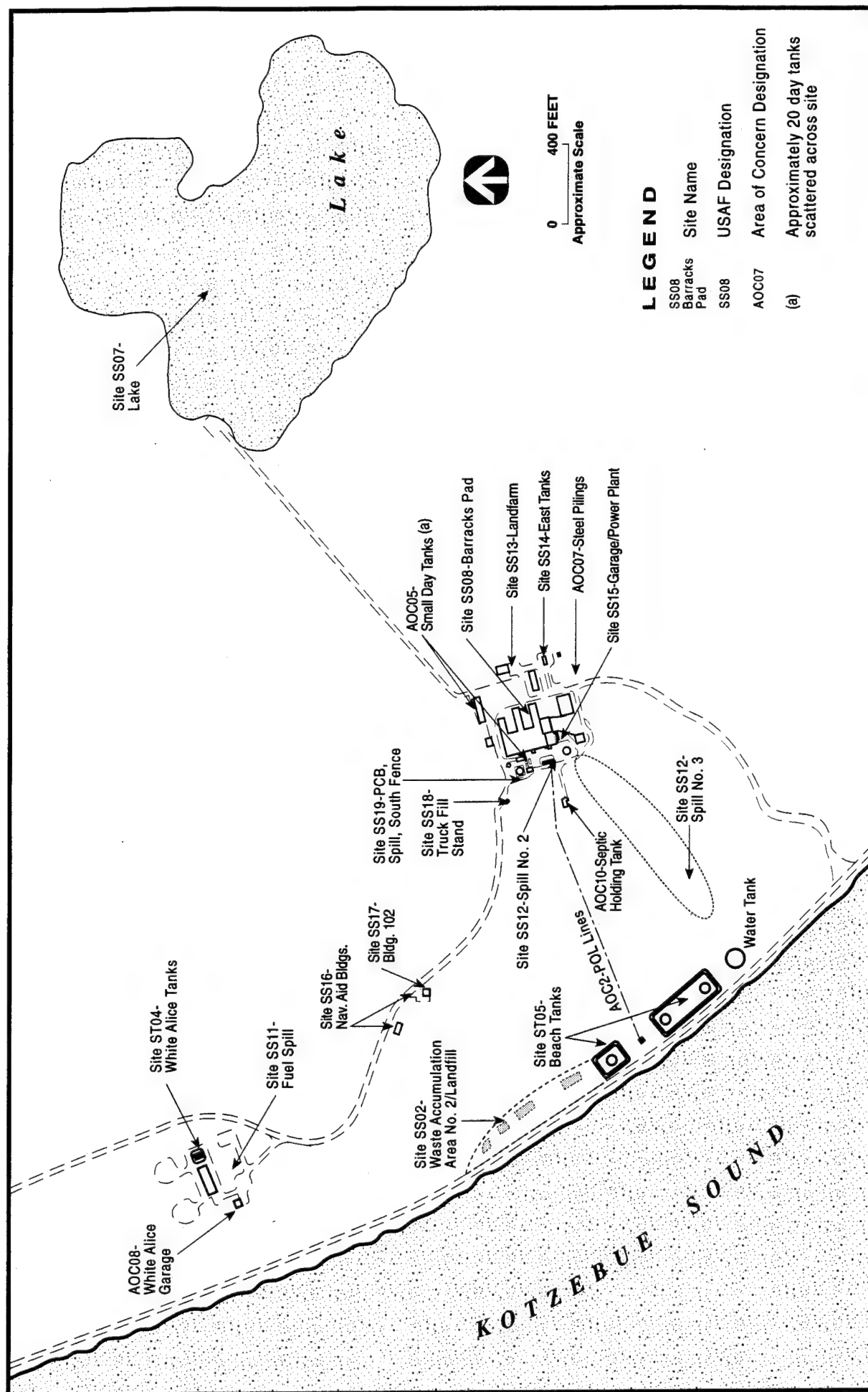


Figure 2-1. Sites and Areas of Concern Investigated During 1994 Remedial Investigation at Kotzebue LRRS, Alaska.

TABLE 2-3. SUMMARY OF FIELD ACTIVITIES CONDUCTED DURING 1994 REMEDIAL INVESTIGATION AT KOTZEBUE LRBS, ALASKA

Site Designation	Facilities Inspection	Field Screening	Hand Auger Sampling	Drilling and Sampling	Installing Wells	Groundwater Sampling	Surface Water Sampling	Seawater Sampling	Free Product Assessment	Tidal Influence	Aquifer Testing	Geotechnical Parameters	Gradiometer Survey	Sample Location Surveying
SS02-Waste Area No. 2/Landfill		•		•	•	•			•			•	•	•
ST05-Beach Tanks		•		•	•	•		•	•	•	•	•		•
SS07-Lake		•	•				•							•
SS08-Barracks Pad		•	•											•
SS11-Fuel Spill		•	•											•
SS12-Spills No. 2 and 3		•	•	•	•	•	•					•		•
SS13-Landfarm (AOC1)		•	•											•
AOC2-POL Lines		•	•											•
SS14-East Tanks (AOC3)		•	•											•
SS15-Power Plant/Garage (AOC4)	•	•	•									•		•
AOC5-Small Day Tanks		•	•											•
SS16-Nav. Aid Bldgs. (AOC6)	•	•	•											•
SS17-Bldg. 102 (AOC6)	•	•	•											•
AOC7-Steel Pilings		•	•									•		•
AOC8-White Alice Garage	•	•	•									•		•
ST04-White Alice Tanks (AOC9)		•	•											•
AOC10-Septic Holding Tank	•	•												•
SS18-Truck Fill Stand (AOC11)		•	•											•
SS19-PCB Spill South Fence (AOC12)		•	•											•
Background Characterization		•	•	•	•	•	•	•						

2.3.1 Field Screening Techniques

Field screening included assessing organic vapors, total petroleum hydrocarbons (TPH), and PCBs.

2.3.1.1 Screening for Organic Vapors. During site reconnaissance, a photoionization detector (PID) was used to locate elevated concentrations of ionizable organic vapors. Elevated readings identified specific areas for potential sampling. During sampling activities, a PID was also used to screen samples and prioritize those selected for laboratory analysis.

2.3.1.2 Screening for TPH and PCB. Field screening of soil samples for the presence of TPH and PCBs was performed using field test kits. TPH screening was performed using a commercially available petroleum hydrocarbon test kit (color indicator). PCB screening was performed using Deksil CLOR-N-SOIL® field test kits.

2.3.2 Environmental Sampling Methods

Environmental samples collected by the field investigation team included surface and subsurface soil, geotechnical, sediment, surface water, groundwater, and seawater samples. Detailed descriptions of sample collection procedures are provided in the FSP (USAF 1994b).

2.3.2.1 Surface and Shallow Subsoil Sampling. Soil samples were selected for analysis either from zones of obvious contamination identified by field screening procedures, the base of gravel fill material, the tundra mat/silt interface, or the top of the permafrost. Surface (0 to 1.0 ft) and shallow subsoil samples (1.0 to 6.0 ft below ground surface) were collected using a clean, stainless steel 3-in internal diameter (i.d.) hand-auger.

2.3.2.2 Subsoil Sampling. Borings for subsoil sampling were advanced using a mobile track-mounted drill rig equipped with 4.25-inch i.d. hollow-stem augers. Borings were advanced using standard drill-and-drive techniques. Standard penetration test data were recorded for each sample drive in blows per 6 inches. A registered geologist supervised the drilling and prepared lithologic logs of borings using the Unified Soil Classification System (USCS). Undisturbed subsoil samples were collected using the Standard Penetration Test procedure split-spoon method. Sample material was selected for laboratory analysis from zones of obvious contamination and based on field screening information.

2.3.2.3 Geotechnical Sampling. Geotechnical sampling included bulk soil samples collected in 1-gallon plastic containers for grain-size analysis. Undisturbed soil samples for permeability testing were collected using Shelby tubes.

2.3.2.4 Lake Sediment Sampling. Relatively undisturbed lake sediment samples were collected from near-shore locations using a clean stainless-steel 3-in. i.d. hand auger.

2.3.2.5 Surface Water Sampling. Surface water samples were collected from lakes, standing water locations at Sites SS12, SS11, SSS13, SS16, and SS17, and from Kotzebue Sound. Extreme care was taken not to suspend sediment in the water prior to or during sampling. Surface water samples were collected prior to collecting sediment samples at all lake locations. A Wheaton surface water sampler was used to collect representative water samples from below the water surface.

2.3.2.6 Groundwater Sampling. Groundwater samples were collected from newly installed near-beach monitoring wells. Monitoring wells were developed and stabilized prior to sample collection. Groundwater was purged from each monitoring well prior to sample collection using a clean stainless steel bailer. Groundwater sampling was conducted in all monitoring wells using a Teflon bailer with a dedicated bailer line [and a Teflon bottom-emptying device for volatile organic compounds (VOC) samples only].

2.3.2.7 Seawater Sampling. The collection of seawater samples was conducted using surface water sample collection procedures. Seawater samples were collected from below the water surface, approximately 5 ft from the high tide mark.

2.3.3 Decontamination Procedures

All equipment that came in contact with potentially contaminated soil, sediment, or water was decontaminated after each use and between each sample location. Equipment decontamination procedures were developed for equipment employed during the field investigation, including specific procedures for large equipment (e.g., drill rig, auger flights, and well casing), small tools and sampling devices (e.g., split-spoons, bailers, hand-augers), and field instruments (e.g., tapes, well sounders, transducers, and water quality probes). Detailed decontamination procedures are outlined in the FSP (USAF 1994b).

2.3.4 Field Quality Assurance/Quality Control

The field quality assurance/quality control (QA/QC) program for Kotzebue LRRS included QC procedures associated with sample collection; periodic audits of field activities of field personnel and subcontractors; and corrective action measures designed to identify and resolve any deviations or non-compliance with contract specifications, approved procedures, the *IRP Handbook*, or the Quality Assurance Project Plan (QAPP). A detailed discussion regarding field QA/QC activities is provided in the QAPP (USAF 1994c).

2.3.4.1 Field Activities Quality Control. QC procedures used during sample collection at Kotzebue LRRS are summarized below:

- A trip blank was shipped with every container of environmental samples sent to the analytical laboratory for analysis of volatile organic compounds.
- A temperature blank was shipped with every container of soil and water samples sent to the laboratory for chemical analysis.
- An ambient condition blank (prepared by pouring Reagent Grade Type II water into sample containers at the sampling site) was collected for every 10 volatile organic compound samples collected, or one per VOC sampling event (whichever was fewer).
- An equipment blank was collected daily from each piece of sampling equipment used to collect 10 or more field samples. If less than 10 samples were collected within a day, equipment blanks were collected based on a running cumulative total, at a 10 percent frequency.
- A duplicate water sample was collected at a frequency of 10 percent to measure sampling and analytical variability. The duplicate samples consisted of two samples collected independently at one sampling location during one act of sampling.

- A replicate soil samples was collected at a frequency of 10 percent to measure sampling and analytical variability. Replicates consisted of two sequential containers with soil from the same field sample.
- Chain-of-Custody forms accompanied all samples.
- Sampling equipment was thoroughly cleaned between each sampling event to prevent cross-contamination of the environmental samples.

2.3.4.2 Field Audits. Periodic audits of field activities of field personnel and subcontractors was performed by the 1994 RI QA Field Auditor. The QA audits were conducted as soon as possible after initiation of each phase of project sampling (e.g., groundwater sampling event). The objectives of the field QA audit are listed below:

- Observe procedures and techniques used during field sampling and analysis
- Check and verify instrument and sampling equipment calibration records
- Assess the effectiveness of and adherence to prescribed QA procedures
- Review document control and Chain-of-Custody procedures
- Review the completeness of data forms and notebooks
- Review any nonconformance reporting procedures
- Identify any weaknesses in the sampling and analytical approach or techniques
- Assess the overall data quality of the various sampling/analytical systems employed at the time of the audit.

The specific details of the field QA audits are provided in the SCS ITIR (USAF 1995a).

2.3.4.3 Corrective Actions. During the field effort at Kotzebue LRRS, the 1994 RI Project Manager and sampling team members were responsible for ensuring that all specified procedures were followed and that measurement data met the prescribed acceptance criteria. Deviations or noncompliance with contract specifications, approved procedures, the *IRP Handbook*, or the QAPP were considered points of nonconformance that could require specific corrective actions. Corrective action procedures for field activities are described in the QAPP (USAF 1994c). Based on the field audit results, no corrective actions were required and no specific points of nonconformance were identified for the 1994 field investigation.

2.3.5 Analytical Program

The analytical program for samples collected at Kotzebue LRRS during the 1994 RI supported: 1) a contaminant assessment, 2) a natural biodegradation assessment, and 3) a fate and transport assessment. A detailed description of each analytical method conducted is provided in the QAPP (USAF 1994c).

2.3.5.1 Contaminant Assessment. Analyses conducted on samples from the sites and the background stations are summarized in Table 2-4, including the number of samples for each media; sample type; the number of analyses and analytical methods for each sample; and the estimated distribution of QA/QC samples. Analyte selection for Kotzebue LRRS sampling sites was determined by evaluating previous IRP site characterization data on suspected and potential hazardous substances associated with historical use and operations. A brief discussion of the rationale for the selection of analytical methods is provided below.

Residual Range Organics (Method AK102-Extended)--Petroleum hydrocarbons were characterized during previous IRP investigations by using EPA Method 418.1. However, no background concentrations were established for the media sampled. Evaluation of existing data suggested that the Method 418.1 measurements did not necessarily define diesel fuel contamination at Kotzebue LRRS. Petroleum hydrocarbon contamination at Kotzebue LRRS from past operations was documented by releases of middle distillates (primarily diesel fuel and jet fuels). For this reason, DROs were measured at Kotzebue LRRS to quantify the extent of petroleum contamination. At sites where waste oils were potentially present (e.g., SS02-Waste Accumulation Area No. 2/Landfill, SS13-Landfarm, SS15-Power

TABLE 2-4. FIELD SAMPLING AND ANALYSES SUMMARY FOR 1994 REMEDIAL INVESTIGATION AT KOTZEBUE LRRS, ALASKA

Site Designation	Media	Number of Samples	Analytes and Methods						
			Gasoline Range Organics (AK101)	Diesel Range Organics (AK102)	Residual Range Organics (AK102 Extended)	Volatile Organics (8260)	Semivolatile Organics (8270)	Pesticides/PCBs (8081)	Metals (6000, 7000 Series)
SS02-Waste Area No. 2/Landfill	Soil	3	NA ^a	3	1	3	3	3	3
	Groundwater	3		3		3	3	3	6
	Surface Water	1		1		1	1	1	2
ST05-Beach Tanks	Sediment	27	NA	24	1	11	11	3	NA
	Groundwater	9		9		9	9		
	Seawater	3		3		3	3		
SS07-Lake	Sediment	3	NA	3	1	1	3	3	2
	Surface Water	3		3		1	3	3	2
Lake Access	Soil	2						2	
SS08-Barracks Pad	Soil	4	NA	4	1	4	4	4	2
SS11-Fuel Spill	Surface Water	1	NA	1	NA	1	1	1	NA
	Soil	5		4		4	4	4	
	Sediment	1		1		1	1	1	
SS12-Spills No. 2 and 3	Soil	38	NA	38	NA	11	11	10	NA
	Sediment	2		2		2	2	2	
	Surface Water	4		4		4	4	4	
SS13-Landfarm (AOC1)	Soil	6	NA	6	2	3	3	3	2
	Soil	7		7		4	4	4	2
	Surface Water	1		1		1			
AOC2-POL Lines	Soil	3	NA	3	NA	3	3	3	NA
SS14-East Tanks (AOC3)	Soil	7	3	7	NA	3	3	3	NA
SS15-Power Garage/Plant (AOC4)	Soil	8	5	8	1	5	5	5	3
AOC5-Small Day Tanks	Soil	23	NA	23	NA	12	12	12	NA
SS16-Nav. Aid Buildings (AOC6) ^b	Surface Water	1	NA	1	2	1	1	1	1
	Soil	6		6		4	4	4	2
	Sediment	1		1		1	1	1	1
AOC7-Steel Pilings	Soil	3	NA	3	NA	3	3	3	2
AOC8-White Alice Garage	Soil	4	4	4	NA	4	4	4	2
ST04-White Alice Tanks (AOC9)	Soil	4	NA	4	NA	3	3	3	NA
AOC10-Septic Holding Tank	Sediment	1	NA	1	1	1	1	1	1
SS18-Truck Fill Stand (AOC11)	Soil	7	7	7	NA	2	NA	NA	2
SS19-PCB Spill South Fence (AOC12)	Soil	1	NA	1	NA	1	1	1	NA
Background Characterization	Soil	4	3	4	1	4	4	4	4
	Lake Sediment	3		3		3	3	3	3
	Beach Sediment	3		3		3	3	3	3
	Groundwater	1		1		1	1	1	2
	Surface Water	3		3		3	3	3	6
	Sea Water	1		1		1	1		
Total Number of Environmental Samples	Soil	131	22	132	11	73	73	74	24
	Sediment	45		42		23	25	17	10
	Groundwater	13		13		13	13	4	8
	Surface Water	14		14		12	13	13	11
	Seawater	4		4		4	4		
QA/QC Samples	Trip	34	2	11	NA	32	9	5	5
	Ambient	12				12			
	Equipment	11	2			10			
	Duplicate								
	• Soil/Sediment	13				8	8	6	1
	• Water	4		4		4	4	1	3

^a NA indicates no analysis for indicated method(s) were performed.^b Site SS17 included in the Characterization of Site SS16.

Plant/Garage, and AOC8-White Alice Garage), Method AK102 was extended to quantify residual range organics (RROs) between C28 and C40.

Diesel Range Organics (Method AK102)--Method AK102, which measures DROs, was selected to characterize petroleum hydrocarbon contamination at most Kotzebue LRRS sites and AOCs. Diesel range organics analyses provided the most appropriate and quantifiable method for determining the magnitude and extent of petroleum hydrocarbon contamination at the facility.

Gasoline Range Organics (Method AK101)--Historical uses and releases of gasoline at Kotzebue LRRS were not documented. To assess potential contamination resulting from gasoline use and spills, gasoline range organics (GROs) analyses were conducted at garage locations (SS15-Power Plant/Garage and AOC8-White Alice Garage) where vehicle storage and maintenance occurred in the past. GROs analyses were also conducted on a site-specific basis if potential gasoline sources were identified or suspected (SS14-East Tanks, SS18-Truck Fill Stand).

Volatile Organic Compounds (U.S. EPA Method 8260)--U.S. EPA Method 8260 was selected to characterize volatile organic contaminants associated with petroleum hydrocarbon contamination, and to evaluate other potential contaminant sources (e.g., waste oils and solvents).

Semivolatile Organic Compounds (U.S. EPA Method 8270)--Previous IRP investigations at Kotzebue LRRS had conducted only limited semivolatile organic compounds (SVOC) analyses. Approximately 10 percent (by weight) of middle-distillate fuels (diesel and jet fuels), which are the primary source of petroleum hydrocarbon contamination at Kotzebue LRRS, consist of semivolatile polycyclic aromatic hydrocarbons. In addition, waste oils and solvents stored and used at the installation may contribute SVOCs at some sites. Method 8270 was used to characterize semivolatile compounds potentially present at Kotzebue LRRS.

Organochlorine Pesticides and PCBs (U.S. EPA Method 8081)--Pesticides may have been used to control insects in the vicinity of the LRRS installation; however, pesticide use has not been documented. Previous investigations had detected relatively low concentrations of organochlorine pesticides, including 4,4'-DDT, at a number of sites. Therefore, Method 8081 was used to analyze samples for these chemicals during the 1994 RI. Method 8081 also measures PCBs, which had been detected in soils

at the White Alice Station and in a sediment sample collected from the former water supply lake during previous IRP investigations. PCB analyses conducted during the 1994 RI included samples of sediments in the former water supply lake (Site SS07), and samples of soils at locations not previously characterized where waste oils might have been present (see Table 2-4).

Metals (U.S. EPA 6000, 7000 Series)--Previous IRP investigations analyzed metals at a limited number of sites, including in soils at the SD03-Road Oiling and SS01-Waste Accumulation Area No. 1 sites, and in surface water at Site SS07-Lake. Metal concentrations in Kotzebue soils were reported to be within the range expected for native soil background concentrations. However, previous investigations did not sample background locations near Kotzebue LRRS for metals analysis to verify this assertion. Since literature values of typical concentrations are not a generally accepted substitute for site-specific background concentrations (*IRP Handbook*), metals analyses were conducted for selected sites based on the past use of waste oils spent solvents at select locations (see Table 2-4).

2.3.5.2 Natural Biodegradation Assessment. Water samples were analyzed for a suite of chemical parameters at two sites at Kotzebue LRRS: groundwater at the ST05-Beach Tanks site, and surface water at the SS12-Spills No. 2 and 3. Sampling at both sites included collection of three samples upgradient and downgradient along a flow path, with both proximal and distal downgradient samples collected and analyzed. At ST05-Beach Tanks, groundwater monitoring wells were also used to evaluate geochemical and contaminant trends in the near-beach aquifer.

Table 2-5 lists the analyses conducted to evaluate natural biodegradation at Kotzebue LRRS. The analyte list was adapted from a draft technical protocol developed by AFCEE for the evaluation of natural biodegradation at sites contaminated with petroleum hydrocarbons (Wiedemeier et al. 1994).

2.3.5.3 Fate and Transport Assessment. Three primary lithologies characterize the Kotzebue LRRS: beach sands and gravels; native soils associated with the tundra hill and surrounding area; and fill material used for roads and facility foundations. To support the contaminant migration assessment for each lithology, three geotechnical samples were collected from each lithology to evaluate physical properties, including permeability and grain size distribution. In addition to geotechnical information, three soil samples from each lithology were collected for the analysis of total organic carbon (TOC) to evaluate the

**TABLE 2-5. FIELD SAMPLING AND ANALYSES SUMMARY FOR
GEOCHEMICAL PARAMETERS FOR 1994 REMEDIAL INVESTIGATION
KOTZEBUE LRRS, ALASKA**

Analyses	Site Designation			
	ST05-Beach Tanks	SS12-Spills No. 2 and 3	Background	SS02-Waste Accumulation Area No. 2/Landfill
Media	Groundwater	Surface Water	Surface Water	Groundwater
Alkalinity (Field Test)	8	3	1	1
Ammonia (Field Test)	8	3	1	1
Chloride (Field Test)	8	3	1	1
Carbon Dioxide (Field Test)	8	3	1	1
Nitrate (Field Test)	8	3	1	1
Phosphate (Field Test)	8	3	1	1
Sulfate (Field Test)	8	3	1	1
Sulfide (Field Test)	8	3	1	1
Total Metals Fe/Na/Ca/K/Mg (EPA Method 6010)	8	3	1	3
Total Organic Carbon (EPA Method 9060)	8	3	1	1
pH (Field Measurement)	9	3	1	3
Temperature (Field Measurement)	9	3	1	3
Specific Conductivity (Field Measurement)	9	3	1	3
Dissolved Oxygen (Field Measurement)	8	3	1	1

potential for contaminant sorption within specific lithologies. The following tests were conducted for geotechnical and TOC characterization:

Test	Test Method	Number of Samples		
		Beach Sands/ Gravels	Tundra	Fill
Soil Permeability	Constant-head (ASTM Method D5084)	3	3	3
Grain Size Distribution	ASTM C136 and D422	3	3	3
Total Organic Carbon (soil)	U.S. EPA Method 9060	3	3	3

2.3.6 QA/QC Program

The QAPP prepared for Kotzebue LRRS describes QA and QC procedures used to accomplish the RI/FS (USAF 1994c). This document includes the QA/QC procedures used for analytical work performed by the laboratory, as well as the procedures used for the collection and management of data generated during the RI/FS process at Kotzebue LRRS. Key aspects of the QA/QC Program for Kotzebue LRRS are summarized below.

2.3.6.1 Data Quality Objectives. Data needs for Kotzebue LRRS included measurements and data of sufficient quality for use in the baseline human health and ecological risk assessments and in the feasibility study. In addition, sufficient information was needed to meet the requirements of the IRPIMS database.

The U.S. EPA has established a hierarchy of data quality objectives (DQOs) which are qualitative and quantitative statements that specify the quality of data required to support regulatory decisions during remedial responses. Data analysis associated with the field effort at Kotzebue LRRS was performed using Level III protocols at a fixed base laboratory, with rigorous documentation performed according to the *IRP Handbook* Level I data reporting requirements. Site-specific health and safety screening, site characterization measurement of parameters during environmental sample collection, geochemical field tests, and gradiometric survey of buried landfill materials were conducted using Level I protocols.

2.3.6.2 Laboratory Audits. The 1994 RI Project QA/QC Manager and QA Auditor conducted an audit at the laboratory, within the first two weeks of the laboratory's receipt of project samples to verify that the QAPP, as well as the appropriate sections of the *IRP Handbook*, were being adhered to. All relevant components of the QAPP and the *IRP Handbook*, and their application to the laboratory's analysis of environmental samples collected during the RI were reviewed. A report addressing the audit results and qualitative assessment of the overall system performance is provided in the SCS ITIR (USAF 1995a).

QA Auditors performed a five percent raw data audit onsite at the laboratory after all project samples had been submitted to the laboratory. During that data audit, the raw data, such as chromatograms and calculations, were compared to previously submitted final data packages for consistency and accuracy. During the raw data audit, manual integration of quality control and other samples were reviewed, and the operation of the instrument specific internal clocks was verified. Results of the five percent raw data audit are provided in the SCS ITIR (USAF 1995a). Ten percent of the final analytical data generated during the RI field effort at Kotzebue LRRS was submitted to a third-party validator. Third-party validation offers an impartial assessment of previously reviewed/validated data. Results of the third-party USAF Level II data review are reported in the Analytical Data ITIR (USAF 1995b).

The final QA/QC report for the RI at Kotzebue LRRS, which contains an analysis of the QA/QC used to assess the quality of data generated during both field and laboratory operations, is provided in the Analytical Data ITIR (USAF 1995b).

Performance Evaluation Check Samples--The laboratory participates in the following performance evaluation (PE) sample programs:

- U.S. EPA Semiannual Drinking Water Performance Check Samples (WS Samples)
- U.S. EPA Semiannual Wastewater Performance Check Samples (WP Series)
- U.S. EPA Contract Laboratory Program (CLP) quarterly blind sample program for organic analysis
- Analytical Products Group P.E.T. blind sample program

- U.S. Department of Energy Quality Assessment Program for Radiochemistry
- U.S. EPA NRA-RADQA Performance Evaluations for Radiochemistry.

Commercially available PE samples were forwarded to the laboratory as part of the blind sample auditing program. This program provides an external auditing function via PE samples to assess the analytical performance of laboratories under contract for non-CLP statements of work. The PE samples were sent to the laboratory from Kotzebue, Alaska, and were submitted as actual environmental field samples to avoid laboratory detection. Performance evaluation sample results are discussed in the five percent raw data audit report (USAF 1995a).

2.3.7 Data Reduction, Validation, and Reporting

Data reduction, validation, and reporting is the process by which analytical data are generated by the laboratory and subsequently reviewed using specified protocols so that the data may be used appropriately.

2.3.7.1 Data Reduction. Data reduction calculations used on data generated during sample collection at Kotzebue LRRS are provided in Analytical Resources SOP (USAF 1994c). All data generated had units consistent with those specified in the *IRP Handbook*. Data storage and documentation was maintained using logbooks and data sheets that were kept on file at the laboratory. All computer-generated raw data were stored on magnetic tape or other media, and will be maintained by the laboratory, along with paper copies, for one year after completion of all analytical tasks.

2.3.7.2 Data Validation. The analytical data review processes conducted by the laboratory during the RI field effort at Kotzebue LRRS are detailed in Table 2-6. Validation of data generated by the laboratory was the responsibility of the Project QA/QC Manager and Data Management Manager. Validation activities were performed according to the *IRP Handbook* and, where applicable, the following documents:

- Contract Laboratory Program National Functional Guidelines for Organic Data Review (U.S. EPA 1994a)

**TABLE 2-6. LABORATORY ANALYTICAL DATA REVIEW PROCESS,
1994 REMEDIAL INVESTIGATION, KOTZEBUE LRRS, ALASKA**

Responsibilities	
Analyst	<ul style="list-style-type: none"> • Sample analysis and raw data generation • Data review - 1st level (bench) • Control charting/verification of acceptable QC results • Analytical notes • Data entry into LIMS • Discrepancy initiation and documentation of corrective actions • Provide copies of log books, as necessary
Supervisor	<ul style="list-style-type: none"> • Oversee daily analytical activities
Section Manager	<ul style="list-style-type: none"> • Ensure program compliance • Review discrepancies requiring manager resolution • Technical conference calls with client
Data Reporting and Review	<ul style="list-style-type: none"> • Generate data reports • Generate forms package • Final data review and validate • Electronic deliverables generation • Data validation • Review of analyst notes and corrective action reports • Supervise contractual and technical compliance • Discrepancy review • Review quality control daily (calibrations, etc.) • Ensure technical validity of data
Quality Assurance	<ul style="list-style-type: none"> • 10 percent contractual compliance review (data packages) <ul style="list-style-type: none"> - Custody when required; - Calculations; - Methods criteria; - QC criteria; - Forms; and - Control charting. • QA auditing
Project Manager	<ul style="list-style-type: none"> • Review and summarize analyst notes/corrective actions • Review packages for completeness and quality • Cover letter/case narrative • Collate organic and inorganic packages • Client/laboratory liaison • Prepare package and paginate • Maintain data package files • Deliver package to client

- Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (U.S. EPA 1994b).

All analytical data were reviewed and, if appropriate, were qualified based on USAF Level I data review specifications. The QAPP provides a detailed discussion regarding the Level I data review criteria used to evaluate project data (USAF 1994c). The data validation review summary and results for Kotzebue LRRS are reported in the Analytical Data ITIR (USAF 1995b).

In addition to the USAF Level I data review, 10 percent of the project data packages from the laboratory were submitted in a USAF Level II [Contract Laboratory Program (CLP)-equivalent] format. The 10 percent USAF Level II data packages were reviewed and validated by a third-party validator. Results of the USAF Level II data review are reported in the Analytical Data ITIR (USAF 1995b).

2.3.7.3 Data Reporting. Data generated during the RI field effort at Kotzebue LRRS were incorporated into the IRPIMS database program. The most recent Contractor Data Loading Tool (CDLT) and QC Tool Program were used for the IRPIMS deliverable, in conjunction with SOPs specified for this task.

All data gathered during the field effort at Kotzebue LRRS are reported in the appropriate ITIRs. The Analytical Data ITIR contains all relevant portions, as detailed in the *IRP Handbook*. In addition to *IRP Handbook* protocol, all data were reviewed using SOPs specific to that task. The resulting reviewed and, if appropriate, qualified data, are provided in the Analytical Data ITIR (USAF 1995b).

3.0 ENVIRONMENTAL SETTING

Two distinct environmental settings are associated with the Kotzebue LRRS: 1) the beach environment adjacent to Kotzebue Sound, and 2) the tundra hill and surrounding area. Because Kotzebue lies above the Arctic Circle, the environmental setting is dominated by long cold winters with short daylight hours and a short cool summer growing season with extended periods of daylight. The environmental setting of Kotzebue Sound and the Baldwin Peninsula, including the physiography, climate, geologic/hydro-geologic characteristics, surface water, oceanography, biological habitats, demographics, and land use, influences how and where plants and animals may be exposed to contaminants from the Kotzebue LRRS.

3.1 PHYSIOGRAPHY

Kotzebue LRRS is located on the Baldwin Peninsula, a marine spit that extends into Kotzebue Sound. The Baldwin Peninsula lies within the Kobuk-Selawik Lowland section of Coastal Western Alaska (see Figure 1-1). This region is characterized by broad river floodplains and lowlands, forming deltas along their seaward margins. The ground surface is composed of moist tundra vegetation, with wet silts and permafrost underlying most of the area (USAF 1990a).

The maximum topographic relief at Kotzebue LRRS is the crest of the tundra hill (elevation of approximately 155 ft above mean sea level) which extends from the Composite Facility toward Kotzebue Sound. Flooding is not known to have been a problem in the area, although the U.S. Army Corps of Engineers indicated that the site is located in a coastal flood hazard zone as designated by the Federal Insurance Administration (USAF 1990a). Periodic flooding of local beaches and adjacent low-lying areas occurs when high tides and high shoreward winds coincide. However, with the exception of the STO5-Beach Tanks and SS02-Waste Accumulation Area No. 2/Landfill sites, all sites at Kotzebue LRRS are located topographically above anticipated flood zones, at elevations ranging from 120 to 155 ft above mean sea level (MSL).

3.2 CLIMATE

The climate of Kotzebue is strongly influenced by the seasonal coverage of sea ice in Kotzebue Sound, which in turn influences water movements and the occurrence and feeding patterns of the migrant and resident organisms that inhabit this region. A maritime climate predominates in summer when the sound is ice-free; a continental climate predominates in winter when the sound is covered with ice. Kotzebue Sound begins to freeze in mid-October and is covered with ice from November to May. Leads begin to develop in the pack ice as early as late May, and typically by late July Kotzebue Sound is free of pack ice. Coastal areas may be covered by shorefast ice for about 8 months of the year. Average annual temperatures range from maximum of 27° F to a minimum of 14° F. Table 3-1 shows the mean number of days per month that the average air temperature is below freezing. The historical record of precipitation indicates relatively low precipitation (mean annual precipitation of 8.5 inches), with over half of the precipitation occurring as rainfall during the summer months of July, August, and September. Mean annual snowfall is 45.3 inches, which occurs primarily during the months of October through April (U.S. Department of Commerce 1986). The total average annual precipitation is approximately 12 inches (USAF 1990a). The maximum 2-year, 24-hour precipitation is 1.8 inches (USAF 1985). No evapotranspiration data are reported for the area. The prevailing wind direction is out of the east-southeast, at an average speed of 11 knots.

Table 3-1. Mean Number of Days With Minimum Air Temperature Less Than 32° F at Kotzebue, Alaska		
Month	Number of Days	Monthly Percentage
January	31	100
February	28	100
March	31	100
April	30	100
May	26	87
June	7	23
July	0	0
August	0	0
September	8	27
October	29	94
November	30	100
December	31	100
Annual	251	69
Source: U.S. Department of Commerce (1986).		

Due to the nature of the climate at Kotzebue LRRS, tundra soils are considered to be frozen for eight months annually. With the annual meltdown (break-up) of the frozen tundra and surface waters during the summer months, contaminants of concern that were frozen during the winter, can become mobile, thereby having the potential for plant or animal exposure.

3.3 GEOLOGY

The Baldwin Peninsula is composed of Quaternary glacial deposits with thicknesses exceeding 150 ft. Beaches are composed of sands and gravels, and the relatively straight shorelines are backed by wavecut terraces that form moderately steep sea cliffs in the unconsolidated glacial sediments (Hayes and Ruby 1979). The area around the Kotzebue LRRS is dominated by glacial moraine and drift deposits, which are overlain locally by a thin sandy beach deposit. The moraine and drift deposits are comprised of clays, silts, sands, and gravels; their total thickness is not known (USAF 1990a).

Permafrost has been identified at relatively shallow depths ranging from less than 1 ft to a maximum of 7 ft below ground surface (BGS) at gravel pad sites located on the tundra hill above Kotzebue Sound beach area. Frozen ground was encountered at varying depths (i.e., minimum depth encountered was approximately 6 ft below ground surface) during the installation of monitoring wells at Kotzebue LRRS beach area. Permafrost is moderately thick in the Kotzebue area and has been reported to a depth of 238 ft below grade. The permafrost is underlain by fine-grained sediments containing brackish subpermafrost water (Williams 1970).

3.4 GROUNDWATER

Groundwater occurs regionally beneath the moderately thick permafrost layer, termed subpermafrost water. Recharge and discharge of subpermafrost groundwater is limited to unfrozen zones that breach the overlying permafrost. Additionally, a very shallow system exists locally above permafrost, termed suprapermafrost water. The region where seasonal temperatures are sufficient to support melting of the near-surface and surface water system, is termed the active zone. Active zone water associated with the

tundra hill sites at Kotzebue LRRS occurs intermittently (seasonally) and is seasonally present as thin, discontinuous, and isolated zones of suprapermafrost water. In this environment, active zone water is considered surface water by ADEC.

Groundwater associated with the beach area at Kotzebue LRRS is restricted to a narrow zone adjacent to Kotzebue Sound, where the depth to permafrost is sufficiently depressed by marine influence to support a continuously saturated subsurface zone. The thickness of the near-beach aquifer system is estimated at approximately 7 to 9 ft, based on a competent silty clay confining layer identified at the ST05-Beach Tanks site (USAF 1995a).

Permafrost is impermeable to groundwater flow because pore spaces that would normally be available for the transport of groundwater are ice filled. Surface water bodies such as lakes, ponds, streams, and rivers, typically depress the upper surface of permafrost, changing the thickness and configuration of permafrost beneath the water body. Permafrost may be entirely absent beneath large water bodies. Because permafrost acts as an impermeable barrier to infiltration and aquifer recharge, surface water runoff is greatly increased in permafrost environments, enhancing the formation of lakes and wetlands.

3.4.1 Subpermafrost Water

The permafrost is underlain by fine-grained sediments containing brackish subpermafrost groundwater; increasing salinity with depth has been reported (Williams 1970; USAF 1990a). The salinity of subpermafrost groundwater in the Kotzebue area has prompted the development of surface water sources to satisfy local water supply requirements (USAF 1990a). The relatively thick permafrost layer beneath the Kotzebue LRRS acts as a confining layer between suprapermafrost surface water and subpermafrost groundwater regimes, inhibiting potential percolation and recharge of the subpermafrost groundwater system.

3.4.2 Suprapermafrost Water (Active Zone)

Active zone water occurs at Kotzebue LRRS in two distinct environments: the tundra hill and surrounding area and the Kotzebue Sound beach area. The tundra hill and surrounding area generally has near-surface silts that extend down to the shallow permafrost. Recharge of the active zone is limited by the low average annual precipitation and fine-grained nature of shallow soils. Flow is assumed to be relatively slow because of the low intrinsic permeability of the silty soils, and transport is likely limited by

seasonal soil freezing in most areas. The occurrence of active zone water at sites associated with the tundra hill is highly variable and locally discontinuous.

The Kotzebue Sound beach area is comprised of coarse sands and gravels. Near-beach groundwater typically occurs between 3 and 4 ft BGS along the steepened beach face immediately adjacent to Kotzebue Sound, and from 6 to 7 ft BGS within the beach tank pads, based on data obtained from monitoring wells installed during the 1994 remedial investigation. The local groundwater flow direction is estimated to be to the southwest, toward Kotzebue Sound. Hydraulic gradients calculated at high tide on 24 July 1994 and low tide on 25 July 1994 fluctuate from 0.0032 ft per ft to 0.0049 ft per ft, respectively along the sample flowpath.

Characterization of the near-beach groundwater system at Kotzebue LRRS indicates that the groundwater is saline (brackish) in nature, is tidally influenced, and represents a non-potable resource. Tidal influences on the near-beach aquifer system can directly affect aquifer gradients and geochemistry, influencing contaminant migration and impacting an evaluation of remedial alternatives. Tidal monitoring and static water level measurements collected during the 1994 remedial investigation indicate that tidal fluctuation in Kotzebue Sound clearly impacts the near-beach aquifer in the vicinity of Kotzebue LRRS. However, based on the limited vertical extent of the water table aquifer and the observed tidal fluctuation, it is unlikely that the tidal cycles have a significant effect on groundwater migration to the sound. Recharge of the near-beach aquifer system has not been addressed by previous studies. Recharge of the beach aquifer is likely controlled by the highly seasonal nature of active zone (suprapermafrost water) inputs that recharge the beach area from the tundra uplands. Kotzebue Sound tidal influence on the system, together with the seasonal nature of freshwater recharge, may result in some seasonal changes with respect to salinity and geochemistry; hydraulic gradients may also be slightly affected. Geochemical results indicated that mixing of seawater occurs in the fore-beach area at Kotzebue LRRS (USAF 1995a).

Natural attenuation processes (including biodegradation) are suggested to be active in the near-beach aquifer system at Kotzebue LRRS. However, the rate of contaminant degradation in groundwater is affected by low groundwater temperatures and lack of basic nutrients which limit the potential growth of indigenous microorganisms identified as capable of metabolizing petroleum hydrocarbons (USAF 1995a).

The seasonally intermittent nature of suprapermafrost water occurrence, and the salinity of subpermafrost groundwater in the Kotzebue area, has prompted the development of surface water sources to satisfy local water supply requirements. However, some domestic consumers in Kotzebue may employ shallow wells screened in spit gravels to obtain suprapermafrost water from a zone ranging between 4 and 20 ft in thickness, although it is very unlikely that this would provide a dependable supply of water because the active zone is frozen for approximately 8 months of each year (USAF 1990a). The domestic wells closest to the installation are all located in the City of Kotzebue, 4 miles away. There are no known uses of surface water or groundwater located within a 3-mile radius of Kotzebue LRRS.

3.5 SURFACE WATER

The surface waters of Alaska are classified in accordance with both their present and their potential utilization to maintain the highest quality standards possible and are distinguished between fresh and marine waters (ADEC 1995). All of the freshwater streams in the Kotzebue LRRS area are classified freshwater IA Water Supply (drinking, culinary, and food processing). Kotzebue Sound is classified as a Marine IIA Water Supply (aquaculture, seafood processing, and industrial) (ADEC 1995).

3.5.1 Surface Water Occurrence

Surface waters associated with Kotzebue LRRS and the surrounding area include Kotzebue Sound, small lakes and ponds, wetlands, bogs, thermokarsts, and small streams. Lake and pond waters are characteristically a brown color due to naturally occurring tannins in the water draining the adjacent tundra (USAF 1990a). Surface water bodies within a one-mile radius of the installation include the following:

- **June Creek**—June Creek is located approximately one mile north of the Composite Facility and flows to the northwest into the large lagoon (brackish) adjacent to Kotzebue Sound. Two small unnamed tributaries of June Creek have been mapped approximately 0.25 miles north and 0.25 miles east-northeast (former LRRS water supply lake outlet) of the Composite Facility (USGS Topographic Map, Kotzebue D2 Quadrangle 1951, Revised 1988). It is suspected that these small tributaries are only active during a relative short period of time in the spring during snow melt (break-up). Aerial photo-

graphs taken over several years indicate that these small tributaries do not provide active flow during the late spring and summer months.

- **LRRS Former Water Supply Lake**--The former Kotzebue LRRS water supply lake is located approximately 0.25 miles east-northeast of the Composite Facility, at an approximate elevation of 37 ft MSL. The lake is approximately 1,000 ft in length and 600 ft wide. However, during the mid and late summer months, the lake's volume is significantly reduced. The total depth of the lake has not been determined, but aerial photographs indicate that the lake is relatively shallow.
- **Wetlands**--Wetlands are located approximately 0.25 miles east of the Composite Facility adjacent to and surrounding the former water supply lake.
- **Kotzebue Sound**--Kotzebue Sound is located approximately 0.25 miles west of the Composite Facility.
- **Miscellaneous Ponds**--Intermittent ponding has been reported southwest of the Composite Facility along the moderately sloping hillside above Kotzebue Sound. The ponded water observed at the installation is a result of rainfall and snow melt, and is most pronounced in late spring/early summer.

3.5.2 Surface Water Drainage

Kotzebue LRRS is situated on top of a tundra hill located approximately 0.25 miles east of Kotzebue Sound. Most of the sites at Kotzebue LRRS range in elevation from 120 ft to 155 ft above MSL. Surface water runoff originating from Kotzebue LRRS is topographically directed either west toward Kotzebue Sound, or east toward the adjacent wetlands. Runoff draining east could potentially reach the former water supply lake.

Melting of the annual snowpack usually occurs over a relatively short time period each year, referred to as break-up, and coincides with the greatest annual surface flow at Kotzebue LRRS. The average break-up and freeze-up dates for the Kotzebue area are 17 May to 8 June and 2 October to 5 November, respectively (Schroeder et al. 1987). Soils remain frozen during much of break-up, and the potential for

contaminant migration via the surface water pathway is suspected to be low (USAF 1990a). Surface water infiltration rates have not been published for Kotzebue, but recharge to the tundra hill active zone is limited by the low average annual precipitation, extended periods of sub-freezing conditions, and low permeability of native soils.

3.5.3 Surface Water Drinking Supply

Historically, the installation used a small lake as a water supply (see Figure 1-2). However, use of the water supply lake was discontinued in 1985 when the installation became a minimally attended radar system. Drinking water at Kotzebue LRRS is currently obtained from the City of Kotzebue. The City of Kotzebue uses Devil's and Vortac Lakes, located near the town, as municipal water supply sources (USAF 1990a).

3.6 OCEANOGRAPHY OF KOTZEBUE SOUND

Kotzebue Sound is a shallow, relatively flat embayment of the southeastern Chukchi Sea, with water depths averaging 46-52 ft and reaching depths of 82 ft (Naidu and Gardner 1988). The tides of Kotzebue Sound are relatively small and are of the mixed, semi-diurnal type. The mean tide range is 2.1 ft and the diurnal tide range is 2.7 ft (U.S. Department of Commerce 1992). Wind-driven currents exert a greater influence on sea level variation than those caused by tides. Strong and persistent westerly winds can cause storm surges and coastal flooding, although the frequency of these events are tempered by the presence of sea ice which reduces the fetch of open water exposed to wind.

The bottom sediments of the sound consist of poorly to very poorly sorted silts with some clay and sand, which indicates a low-energy depositional environment (Naidu and Gardner 1988). The relatively high organic carbon content (as high as 1.9 mg/kg dry weight) of the bottom sediments of Kotzebue Sound are associated with fine, poorly sorted sediments. The sediment organic matter may be terrestrial, originating from the discharge of rivers and smaller coastal streams (Naidu and Gardner 1988). The Noatak River, which enters Kotzebue Sound at the outlet of Hotham Inlet (Kobuk Lake) approximately 10 miles north of Kotzebue, contributes significant quantities of suspended sediment to Kotzebue Sound. The sediment plume from the Noatak may flow in either of three general directions: 1) east into Hotham Inlet (Kobuk Lake), 2) westward along the northern shoreline of the sound and then northwest to Point

Thompson, and 3) southward along the shoreline in front of the City of Kotzebue and into the central basin of Kotzebue Sound. A portion of the Noatak sediment plume has been observed along the west shore of the Baldwin Peninsula as far south as Cape Blossom (Scott 1977).

The predominant water flow in Kotzebue Sound is directed into the southeastern Chukchi Sea (Johnson 1988). The circulation and physical properties within Kotzebue Sound are influenced by ice formation and melting during fall and spring, and freshwater river inputs from rivers and streams during summer. Melting sea ice and the input of freshwater reduce surface water salinity and lead to stratification of the water column in spring and summer. Depending on river flow, wind, and tides, freshwater input from the Noatak River, and from the Kobuk and Selawik rivers via Hotham Inlet (Kobuk Lake), can lead to the occurrence of low salinity water along the shore of the City of Kotzebue (Georgette and Loon 1993). Ice formation during fall and winter leads to increasing bottom salinity and cooler bottom water temperatures, which results in outflow of bottom waters from Kotzebue Sound (Kinder et al. 1977). During summer the sound becomes stratified. In the outer portion of the sound there appears to be a three-layered system, where near-surface and near-bottom waters flow out of the sound; water at intermediate depths enters the sound. The occurrence during summer of a weak inflowing current around Cape Espenberg and a weak outflowing current around Cape Krusenstern has also been reported (Scott 1977). The inner portion of Kotzebue Sound is stratified into two layers during summer, with a sharp pycnocline due to changes in both temperature and salinity with depth (Kinder et al. 1977). Currents within the sound have been described as weak and variable, and predominantly tidal (Flemming and Heggarty 1966).

3.7 BIOLOGICAL HABITATS

The Baldwin Peninsula is a long narrow rolling upland composed of Quaternary gravel till and loess deposits, covered with a thin layer of water-laid silt and peat lenses (McCulloch et al. 1965; McCulloch et al. 1966). The entire peninsula is covered with tundra vegetation. Because of the location and morphology of the Baldwin Peninsula, there are a number of characteristics of the peninsula that distinguish it from the nearby areas of the mainland. These characteristics include the following:

- Although the northern limit of tree growth is approximately 75 miles north of Kotzebue, the environment of the Baldwin Peninsula is treeless (Georgette and Loon 1993). However, small dwarf shrubs, primarily willows and alder, can be found.
- Because of the limited land access via the narrow peninsula, few caribou or moose occur on the peninsula. The predators of these large land animals (e.g., wolves, brown bear, and grizzly bear) are also infrequent visitors to the peninsula.
- Because the peninsula lies within the relatively protected waters of Kotzebue Sound, marine mammals that follow the pack ice (e.g., walrus, bearded seal, polar bear) typically occur within the sound only for a short period in spring when leads open in the sea ice.
- No large rivers are found on the peninsula. The Noatak River, located approximately 10 miles north of Kotzebue, is the nearest river where anadromous fish spawn.
- Large nesting colonies of seabirds are absent, except at the southern end of the peninsula near the mouth of Eschscholtz Bay, approximately 45 miles to the south of Kotzebue (Divoky and Springer 1988).

Important features of the region north of the Arctic Circle are the seasonal activity of resident and migrant species and the occurrence of permafrost. In general, the long cold winters preclude activity by all but the hardiest of resident species. Notable among these are the Arctic hare and the snowy owl. However, beginning in May or early June there is a burst of activity, particularly due to the influx of migratory birds and marine mammals, spawning of fish (particularly herring and salmon), and the growth of tundra vegetation that attracts humans as well as wildlife.

Tundra vegetation and shallow ponds and wetlands form the basis of the terrestrial ecosystem in the vicinity of the radar station. Because of the limited drainage due to shallow permafrost, much of the terrestrial environment may be considered wetland. A number of small ponds and lakes occur within the boundaries of the Kotzebue LRRS. These habitats support a variety of plant species, which in turn support small mammals and their predators. The detritus produced by aquatic plants also supports benthic

insect larvae and plankton, which in turn supports migrant species of water birds, including phalaropes and loons.

3.8 PLANT HABITATS

Moist tundra vegetation surrounds Kotzebue LRRS. The soil is commonly saturated, resulting from permafrost conditions and cool weather which reduces the extent of evaporation. These factors combine to favor herbaceous species and low shrubs with shallow roots that are adapted to wetland terrain. Shrubs are favored in locations where drainage and the depth of frozen ground combine to allow deeper penetration of roots. The predominant vegetation type of drier upland areas is cotton grass, which forms dense tussocks. In wetter areas, species of sedge and horsetail rush are found, as well as a number of ericaceous plants. The ground is covered with a variety of edible plants which are harvested by the local community for subsistence consumption. Kotzebue residents use berry and plant resources as a supplement to their primary diet of fish and meat. Berries and plant resources can be harvested only during short periods of time, due to the typical Arctic growing season.

3.9 DEMOGRAPHICS

Kotzebue LRRS is operated as a minimally attended radar installation. A radar maintenance technician is reportedly present at the station 24 hours a day. Radar maintenance technicians are housed in the City of Kotzebue.

Kotzebue, Alaska, has an estimated population of 3,649 people based on the 1991 federal census results. The community of Kotzebue serves as a regional service and distribution center for the Northwest Arctic Borough, an area of 37,300 square miles incorporating 11 villages: Kotzebue, Ambler, Buckland, Deering, Kiana, Kivalina, Kobuk, Noatak, Noorvik, Selawik, and Shungnak. Fifty five percent of the population distribution within the Northwest Arctic Borough resides in the 10 smaller villages, with the remaining 45 percent residing in Kotzebue. Kotzebue is a predominantly Inupiat community, with Alaska Natives comprising 75 percent of its population (Fall and Utermohle 1993). Historically, Kotzebue has grown as a transportation hub for river travel along the Noatak, Kobuk, and Selawik Rivers, as well as

for air travel to northern Alaska. Kotzebue's position as a modern regional center emerged after World War II, largely owing to the establishment of government facilities and services there. Much of Kotzebue's population growth has resulted from influx from surrounding villages (Fall and Utermohle 1993).

The Kotzebue economy is sustained by the regional offices and facilities of the many state and federal agencies that serve northwest Alaska and are located in Kotzebue (USAF 1990a). The top source of income is from jobs relating to federal, state and local governments, including jobs associated with schools. Employment by industry indicates that most jobs were in services (25 percent), commercial fishing (14 percent), education (13 percent), and retail trade (11 percent) (Fall and Utermohle 1993).

It is estimated that greater than 70 percent of Kotzebue's population engages in subsistence activities, including an estimated 69 percent processing wild resources (e.g., cleaning and preparation of wild game, drying fish, canning), 36 percent hunting, 53 percent fishing, 3 percent trapping, and 61 percent gathering wild plants (Fall and Utermohle 1993). The total subsistence harvest by resource is comprised of land mammals (especially caribou and moose) at 31 percent, fish other than salmon (e.g., sheefish) at 27 percent, marine mammals (e.g., bearded seals) at 26.8 percent, and salmon (primarily chum salmon) at 13 percent (Fall and Utermohle 1993).

3.10 LAND USE

Currently, Kotzebue LRRS is used solely as a minimally attended radar facility, with no active housing facilities or military presence. PMC-Frontec is responsible for maintenance of real property facilities, which includes the radar facility, abandoned buildings, roads, grounds, and antenna structures. The active portion of the installation, including the radar facility and nearby structures, is completely fenced and secure. Abandoned housing facilities and other structures surrounding the radar facility are closed to the public, but are located outside the fenced area (USAF 1993).

The property occupied by Kotzebue LRRS is not used by other private or governmental agencies, with the exception of the Navigational Aid Building 101 currently used to house experimental equipment belonging to the Geophysical Institute at the University of Alaska. However, the area does provide suitable habitat for a wide variety of wildlife, and subsistence and recreational use may occur within or

near installation boundaries. Subsistence use may include berry picking in adjacent tundra wetlands, terrestrial hunting along the tundra hill and surrounding area, and marine hunting and fishing along the Kotzebue Sound beach area. Recreational uses may include all terrain vehicle (ATV) use along roads and beach areas, summer picnicking and wading along beach areas, beach combing, and recreational hunting and fishing. Additionally, the beach area near Kotzebue LRRS has been reportedly used as a staging area for commercial fishing of chum salmon and as a rifle range by local residents (USAF 1993).

Kotzebue LRRS is anticipated to maintain radar facility operations at current (or possibly reduced) levels over the next few years. Remedial actions at IRP sites and demolition of abandoned structures are future activities anticipated at the installation. Future demand of fisheries and wildlife are primarily linked to native subsistence use, with resource management in the area under the jurisdiction of the Alaska Department of Fish and Game. Future outdoor recreation activities at Kotzebue LRRS and surrounding area are anticipated to be consistent with current recreational uses associated with the area (USAF 1993). Future land use issues and strategies associated with Kotzebue, Alaska and surrounding areas have been considered by the Northwest Arctic Borough (NAB) and are presented in the NAB Comprehensive Plan (NAB 1992).

4.0 DATA EVALUATION

This section describes the quality of the data generated during the 1994 RI and discusses the factors that determine the useability of these data.

4.1 DATA EVALUATION

There are several factors to consider in assessing the useability of environmental data in baseline risk assessments (U.S. EPA 1990d). In addition to the data quality criteria goals, the source, documentation, analytical methods/detection limits, and level of review associated with the data can all affect the useability.

Based on RI data review and data validation results, the quality criteria goals for accuracy, precision, and completeness were met. All data gathered during the field effort at Kotzebue LRRS were reported in the appropriate Analytical Data Informal Technical Information Reports (ITIR). All data reviewed, including the resulting qualified data (as required), are provided in the Analytical Data ITIR (USAF 1995b). Data points qualified as estimated were still considered useable for this baseline assessment, although the final risk estimates for compounds with estimated data points might be more uncertain. Detected values which were less than 5X (or 10X for common laboratory contaminants such as methylene chloride and phthalates) greater than concentrations detected in associated laboratory blanks were qualified as undetected.

The source of analytical data used in risk assessments is typically only an issue if data from different investigations are used. For this baseline risk assessment, only data from the 1994 RI were used. Documentation of field and laboratory procedures is important so the effect of any deviation from these procedures on data useability can be assessed. Extensive documentation was prepared for the RI (USAF 1994a,b,c,d). In addition, both field and laboratory audits were performed. No deviations from project guidelines were noted which would adversely affect the useability of the analytical data (USAF 1995a).

Detection limits [i.e., practical quantitation limits (PQL)] can affect data useability if they are higher than risk-based screening concentrations. Potential risk from these chemicals can be quantified, but the uncertainty of these estimates is greater than for chemicals for which the PQL was lower than risk-based screening concentrations. The PQL exceeded risk-based screening concentrations for many chemicals measured at Kotzebue LRRS (see Section 5.1). The potential risk from these chemicals was evaluated separately from chemicals which were detected above the screening concentrations.

The level of analytical data review can also affect data useability. All data used in this baseline assessment were subject to a thorough data reduction and validation process, as described in the RI report (USAF 1995a).

4.2 DEFINITION OF INVESTIGATIVE AREAS

The 1994 RI included the collection of more than 200 samples from sites at Kotzebue LRRS (see Table 2-4) (USAF 1995a). Sampled media included soil, sediment, surface water (fresh and marine), and groundwater, although all media were not collected at any single site. The size and complexity (i.e., number of media, drainage patterns, soil characteristics) of the area warrants its division into separate investigative areas, each of which can be evaluated independently. By making these divisions, the size of the area which could potentially require remediation (assuming conditions were identified which were hazardous to ecological receptors) may be reduced.

The characteristics that were considered in dividing the Kotzebue LRRS into separate investigative areas are listed below:

- Surface water drainage patterns
- Areal extent of each sampling site
- Historical spill locations
- Results of previous site investigations
- Distribution of human and ecological receptors

Four separate investigative areas were defined based on these considerations (Figure 4-1). Three of these areas (White Alice, West Drainage, and East Drainage) include both terrestrial and freshwater com-

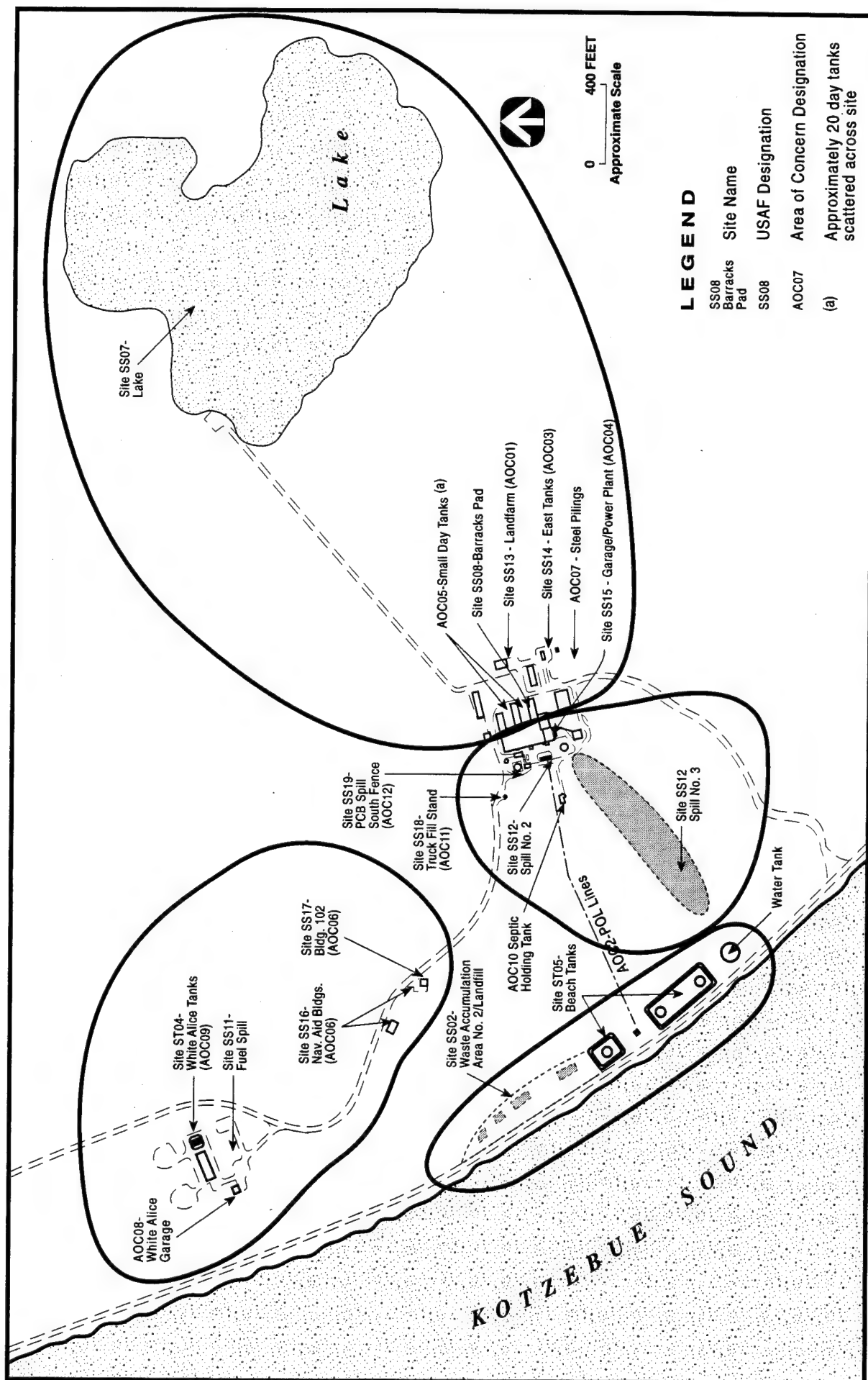


Figure 4-1. Investigative Areas For Baseline Risk Assessment, Kotzebue LRRS, Alaska.

munities, while the Beach area includes the marine community. A fence surrounding the radar dome (Site SS19) effectively prevents access by recreational users to part of the West Drainage area. Surface water bodies from the White Alice and West Drainage areas tend to flow west toward Kotzebue Sound, although they probably do not mix before entering the marine environment. The majority of the surface water from the East Drainage area flows east toward the adjacent wetlands and may even reach the former water supply lake. The Beach area was distinguished from the West Drainage area because of the difference in soil characteristics (coarse gravel at Beach area and tundra at West Drainage area) and the fact that the sites within the Beach area have more immediate exposure to Kotzebue Sound and are tidally influenced. Listed below are the sampling sites which make up each of the four areas:

<u>Investigative Area</u>	<u>Sampling Sites</u>
White Alice (Figure 4-2)	Site SS16 (AOC06; Navigational Aid Buildings) AOC08 (White Alice Garage) Site ST04 (AOC09; White Alice Tanks) Site SS11 (Fuel Spill) Site SS17 (AOC06; Building 102)
Beach (Figure 4-3)	SS02 (Waste Accumulation Area No. 2/Landfill) ST05 (Beach Tanks)
West Drainage (Figure 4-4)	AOC02 (POL Lines) Site SS15 (AOC04; Power Plant/Garage) AOC10 (Septic Holding Tank) Site SS18 (AOC11; Truck Fill Stand) Site SS19 (AOC12; PCB Spill South Fence) Site SS12 (Spills No. 2 and 3)
East Drainage (Figure 4-5)	Site SS13 (AOC01; Landfarm and Landfarm Seeps) Site SS14 (AOC03; East Tanks) AOC05 (Small Day Tanks) AOC07 (Steel Pilings) Site SS07 (Lake and Lake Access) Site SS08 (Barracks Pad)

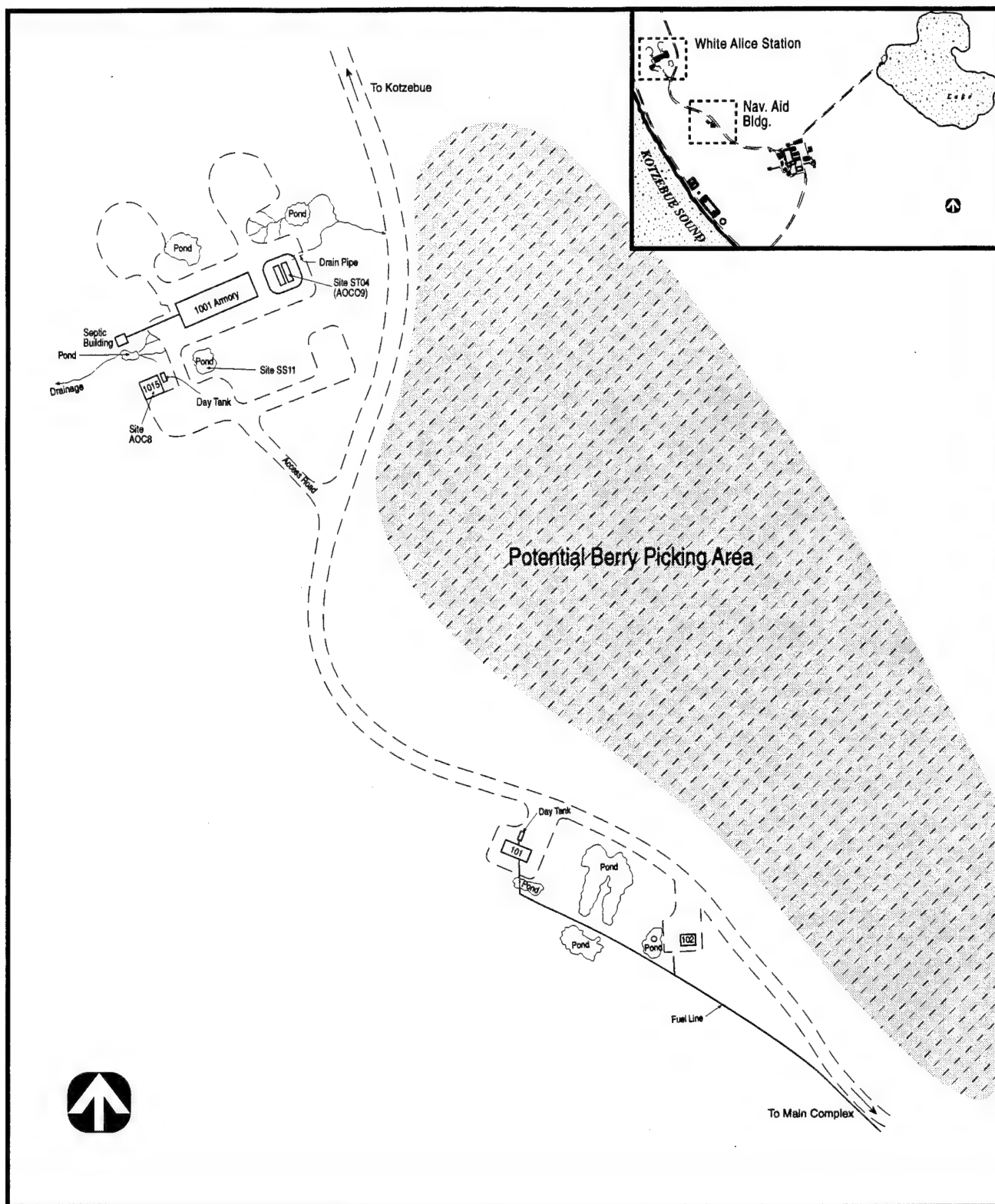


Figure 4-2. Navigational Aid Buildings and White Alice Area, Kotzebue LRRS, Alaska.

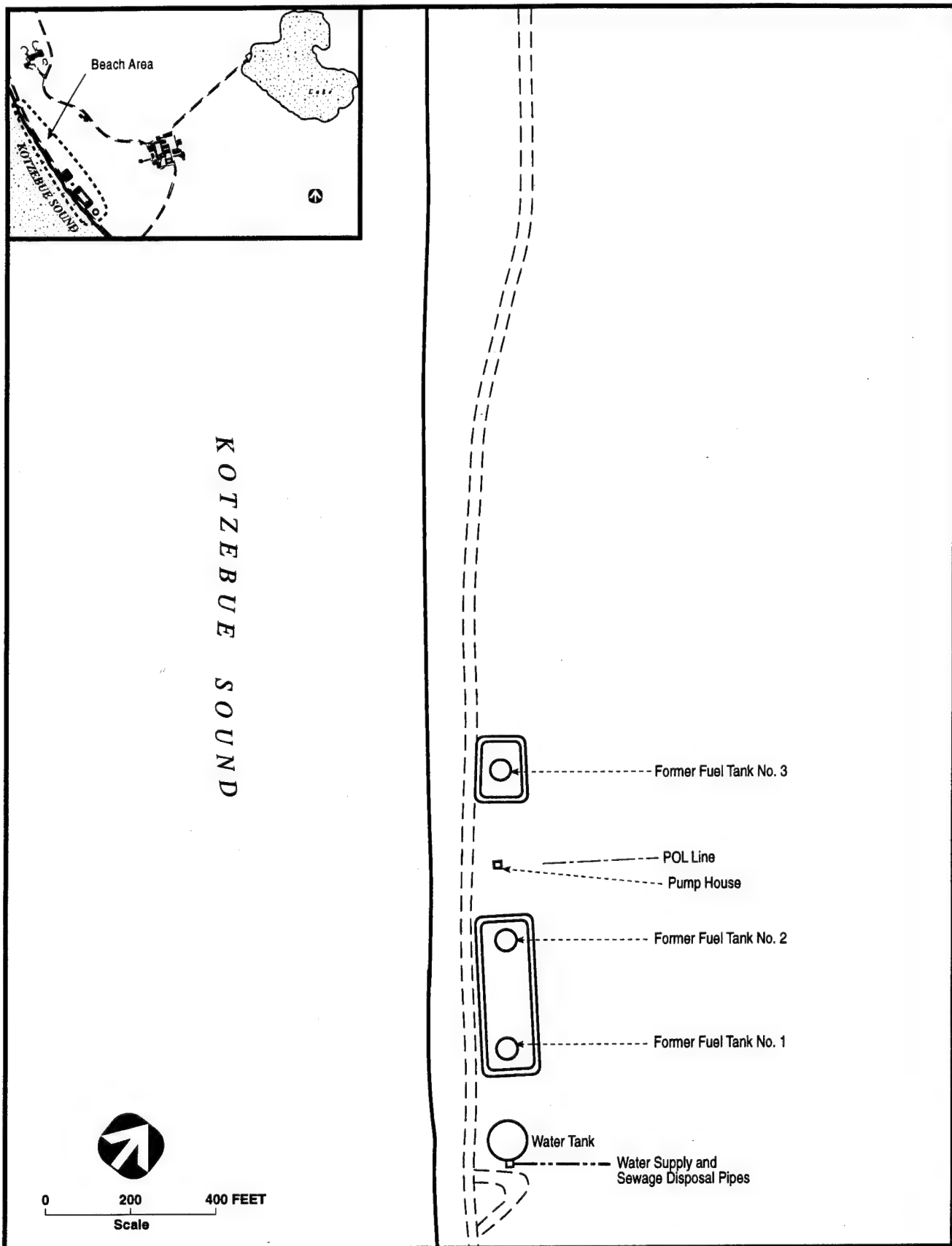


Figure 4-3. Beach Area, Kotzebue LRRS, Alaska.

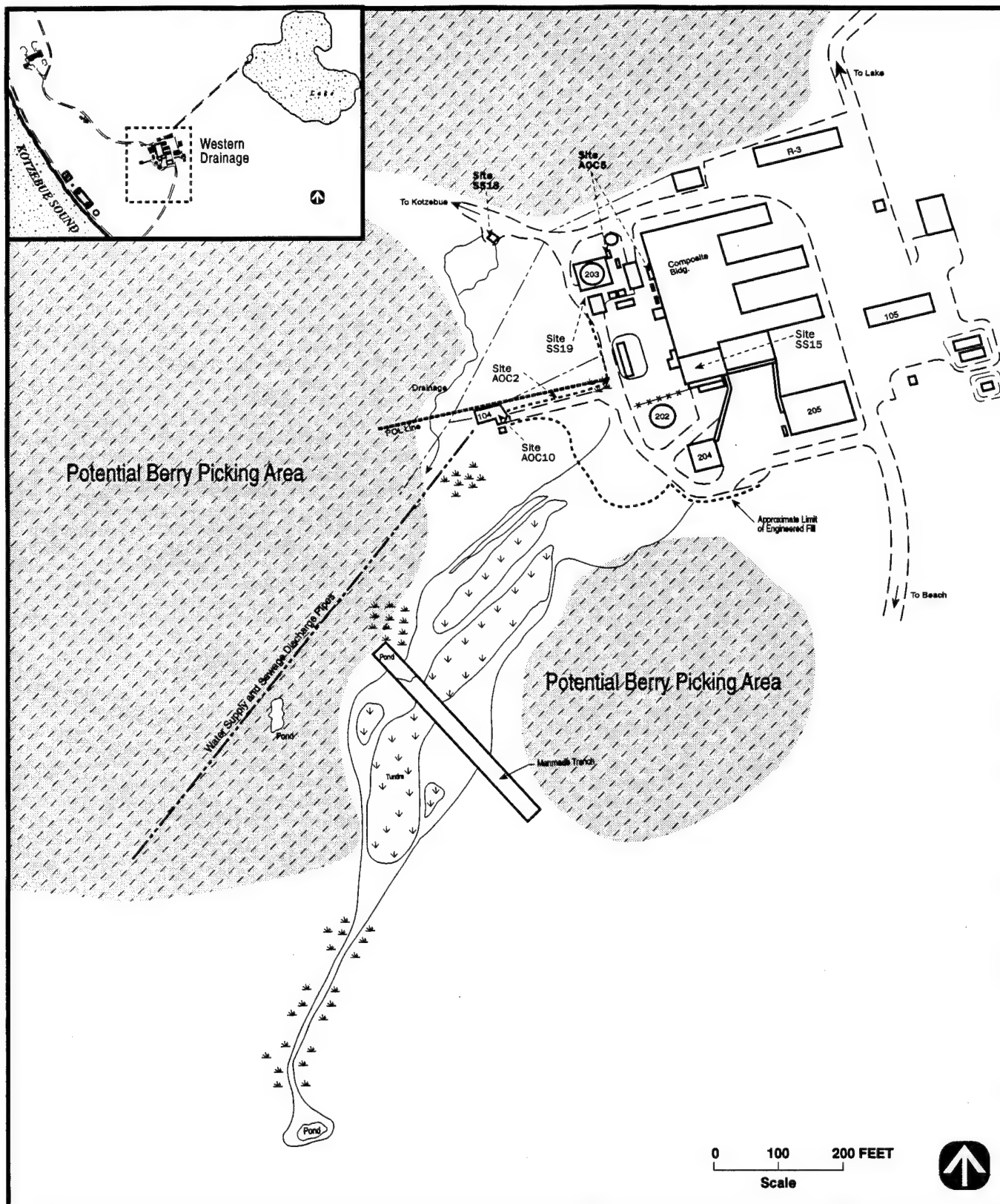


Figure 4-4. Western Drainage Area, Kotzebue LRRS, Alaska.

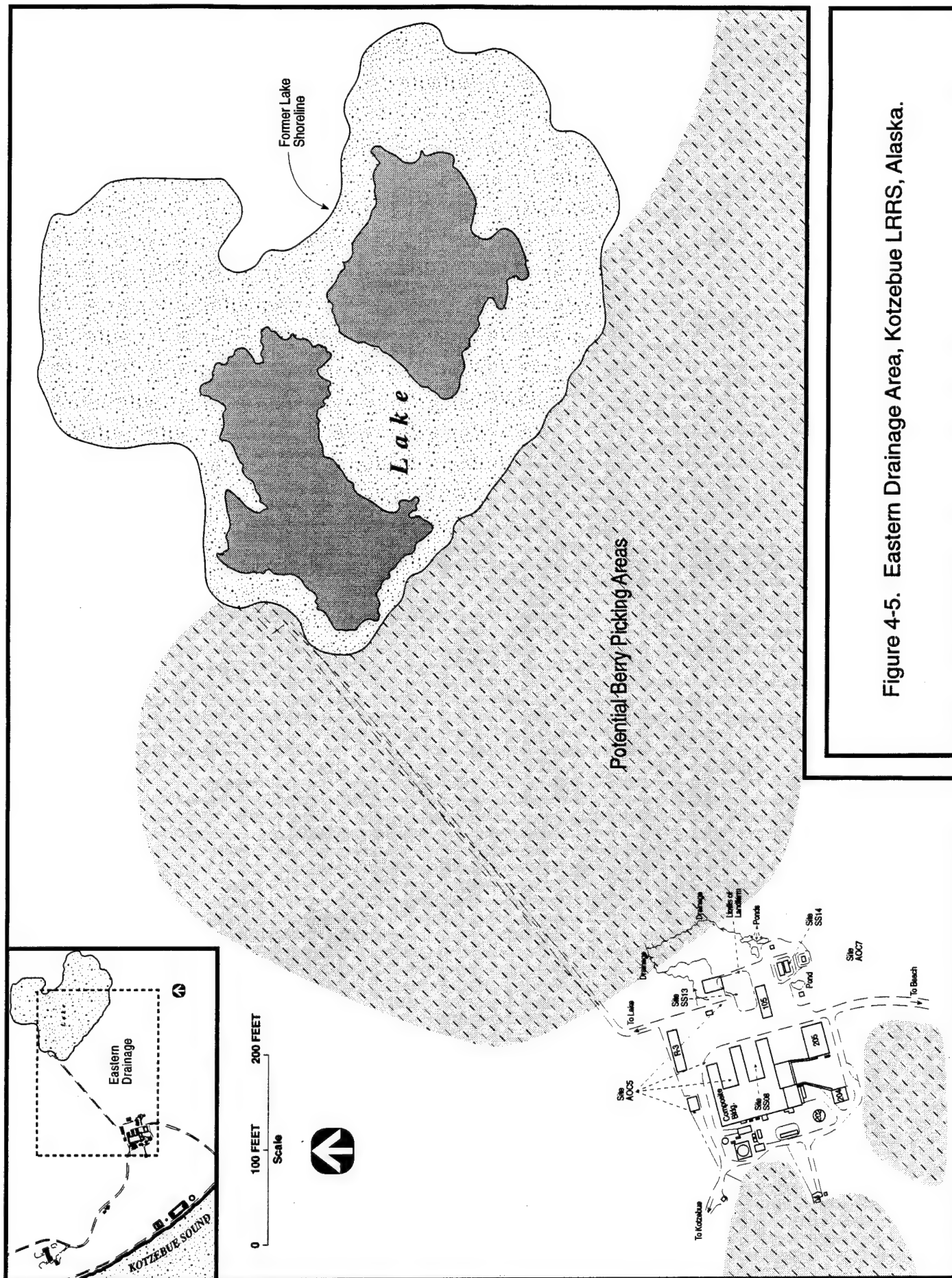


Figure 4-5. Eastern Drainage Area, Kotzebue LRRS, Alaska.

5.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section presents the baseline human health risk assessment as described in Section 1.1 (Scope) and includes separate subsections for selection of contaminants of potential concern (COPC), exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis.

5.1 CONTAMINANTS OF POTENTIAL CONCERN

The results of the 1994 RI are reported in detail in the RI/FS report (USAF 1995a) and in Appendix A. Samples were analyzed for total petroleum hydrocarbons (TPH; gasoline range organics (GRO), diesel range organics (DRO), and residual range organics (RRO)), volatile organics compounds, semi-volatile organic compounds, pesticides and PCBs, and metals. Not all samples were analyzed for all target analytes. Because contaminants at Kotzebue LRRS are not limited to a particular class of chemical and many different compounds were detected during the 1994 RI (USAF 1995a), a screening assessment was performed to identify COPCs. The screening is described in Section 5.1.1, followed by a presentation of the COPC concentrations for the reasonable maximum exposure (RME) scenario in Section 5.1.2.

5.1.1 Risk-based Screening Assessment

A screening of the contaminant data was performed to determine which chemicals might pose a potential human health risk. The screening consisted of the following four steps: 1) compare maximum detected concentration for each chemical in each medium with risk-based screening concentrations (RBCs), 2) compare maximum PQLs to RBCs for chemicals which were not detected, 3) identify organic chemicals which were detected but for which no RBCs are available, and 4) compare maximum concentrations to mean background concentrations for metals without RBCs. Each of these steps is described in greater detail below.

RBCs were obtained from U.S. EPA (1991c) Region 10 Supplemental Risk Assessment Guidance for Superfund and are given in Appendix Table B-1. The RBCs correspond to a cancer risk of 10^{-6} (10^{-7} for soil) or a hazard quotient (non-carcinogen) of 0.1. If both values were available for a particular chemical, the lower of the two values was used. Water RBCs were used for both surface water and groundwater data and soil RBCs were used for both soil and sediment data. The maximum concentration for each chemical in each medium was compared to the appropriate RBC. If the maximum concentration exceeded the RBC, the chemical was considered a COPC and was carried through the baseline human health risk assessment. For chemicals which were not detected at Kotzebue LRRS, an additional screening was performed to determine if the PQL exceeded the RBC. If the maximum PQL for a chemical in a particular medium exceeded the appropriate RBC, that chemical was added to the list of COPCs. Because the risk attributed to COPCs which were not detected above PQLs is less certain than risk attributed to detected COPCs, the two groups of chemicals were evaluated separately. If neither the maximum detected concentration or the maximum PQL exceeded the RBC, that chemical was not considered a COPC and was not evaluated further.

RBCs were not available for chemicals which did not have toxicity data (i.e., reference dose or slope factor). Organic chemicals in this category were also added to the list of COPCs if they were detected at Kotzebue LRRS. Exceptions to this rule were made for the TPH fractions (diesel and gasoline) because toxicity data for the weathered fuels typical of TPHs are not available. Human health risk due to hydrocarbons was assessed by characterizing the risk from the semi-volatile and volatile organic compounds which make up TPH. Metals in this category were added to the list of COPCs if they were detected at greater than three times (3X) the mean background concentration for a particular medium. Although these chemicals were considered to be COPCs, risk was not quantitated due to the lack of toxicity data. The list of COPCs for each medium is given in Table 5-1. A total of 89 COPCs were identified using the approach described above. Within each of the four media, the number of COPCs ranged from 45 for sediment to 71 for groundwater. The majority of the COPCs were never detected at Kotzebue LRRS above the PQLs (category 2 in Table 5-1). This is particularly true for surface water and groundwater, where only 7 chemicals in each medium were considered to be COPCs based on detected concentrations.

**TABLE 5-1. CHEMICALS OF POTENTIAL CONCERN (COPC) BY MEDIA FOR THE
BASELINE HUMAN HEALTH RISK ASSESSMENT, KOTZEBUE LRRS, ALASKA (Page 1 of 2)**

Chemical	Media			
	Sediment	Soil	Surface Water	Groundwater
Metals				
Antimony	2	2		
Arsenic	1	1	2	2
Beryllium	1	1		
Cadmium	2			
Lead	4	4		
Magnesium			4	
Manganese			1	1
Selenium	2			
Thallium	1	1		
Pesticides/PCBs				
4,4'-DDD	1	1		
4,4'-DDE	1	1		
4,4'-DDT	1	1		1
Aldrin	2	1	1	2
Arochlor 1016	2	2	2	2
Arochlor 1221	2	2	2	2
Arochlor 1232	2	2	2	2
Arochlor 1242	2	2	2	2
Arochlor 1248	2	2	2	2
Arochlor 1254	1	1	2	2
Arochlor 1260	1	1	2	2
Dieldrin	2	1	1	2
Endrin Aldehyde		3		
Heptachlor	2	1	1	
Heptachlor Epoxide	1	1	1	2
Toxaphene	2	2	2	2
alpha BHC	1	1	1	
beta BHC		1	1	
delta BHC	3	3	3	
Semi-volatile Organics				
1,2,4-Trichlorobenzene				2
1,4-Dichlorobenzene		2		2
2-Methylnaphthalene		3		3
2,2'-Oxybis (1-Chloropropane)	2	2	2	2
2,4,6-Trichlorophenol		2	2	2
2,4-Dichlorophenol				2
2,4-Dinitrophenol			2	2
2,4-Dinitrotoluene	2	1	2	2
2,6-Dinitrotoluene	2	1	2	2
2-Nitroaniline		1	2	2
2-Nitrophenol		3		
3,3'-Dichlorobenzidine	2	2	2	2
3-Nitroaniline	2	2	2	2
4-Chloroaniline				2
4-Nitroaniline	2	2	2	2
Acenaphthylene				3
Benzo(a)anthracene	2	1	2	2
Benzo(a)pyrene	2	1	2	2
Benzo(b)fluoranthene	2	1	2	2

**TABLE 5-1. CHEMICALS OF POTENTIAL CONCERN (COPC) BY MEDIA FOR THE
BASELINE HUMAN HEALTH RISK ASSESSMENT, KOTZEBUE LRRS, ALASKA (Page 2 of 2)**

Chemical	Media			
	Sediment	Soil	Surface Water	Groundwater
Benzo(k)fluoranthene	2	2	2	2
Chrysene	2	1	2	2
Dibenzo(a,h)anthracene	2	2	2	2
Dibenzofuran				2
Hexachlorobenzene	2	2	2	2
Hexachlorobutadiene	2	2	2	2
Hexachlorocyclopentadiene				2
Hexachloroethane		2		2
Indeno(1,2,3-c,d)pyrene	2	2	2	2
Isophorone		2		
N-Nitrosodi-n-propylamine	2	2	2	2
N-Nitrosodiphenylamine		2		
Naphthalene				1
Nitrobenzene		2		2
Pentachlorophenol	2	2	2	2
Phenanthrene		3		3
bis(2-Chloroethyl) Ether	2	2	2	2
bis(2-Ethylhexyl) Phthalate		2		1
<i>Volatile Organics</i>				
1,1,2,2-Tetrachloroethane	2	2	2	2
1,1,2-Trichloroethane			2	2
1,1-Dichloroethene	2	2	2	2
1,2-Dichloroethane			2	2
1,2-Dichloropropane			2	2
2-Hexanone		3		
Benzene			2	1
Bromodichloromethane		2	2	2
Bromoform				2
Bromomethane			2	2
Carbon Disulfide				2
Carbon Tetrachloride		2	2	2
Chlorobenzene				2
Chloroform			2	1
Chloromethane				2
Dibromochloromethane				2
Methylene Chloride				2
Styrene				2
Tetrachloroethylene (pce)				2
Trichloroethylene (tce)				2
Vinyl Chloride	2	2	2	2
Xylenes, total				1
cis-1,3-Dichloropropene		2	2	2
trans-1,3-Dichloropropene		2	2	2
Key: 1 = Detected concentration exceeded screening value 2 = Practical Quantitation Limit (PQL) exceeded screening value 3 = No screening value available; chemical was detected 4 = No screening value available; metal detected > 3X mean background concentration				

5.1.2 COPC Concentrations for Reasonable Maximum Exposure Scenario

The RME scenario is a conservative approach whereby the exposure point concentration (EPC) that a particular individual is likely to be exposed to is defined as the 95 percent upper confidence limit (UCL) of the available sampling data for each investigative area/medium combination (U.S. EPA 1991c). In cases where the 95 UCL exceeds the maximum concentration, which is possible given a highly variable group of data points, the maximum concentration is used for the EPC. The EPCs for each of the COPCs given in Table 5-1 are given in Appendix Table B-2. For COPCs which were not detected, one-half the PQL was used for the EPC, as suggested in U.S. EPA (1991c).

5.2 EXPOSURE ASSESSMENT

An exposure assessment was conducted to estimate the type and magnitude of chemical exposures that humans may encounter at the Kotzebue LRRS site. The primary goals of the exposure assessment included:

- Site characterization
- Identification of potential human receptors and exposure pathways
- Determination of potential exposure scenarios, including the frequency and duration of exposure to COPCs
- Quantitative evaluation of the potential chemical exposures using measured and predicted estimates of chemical concentrations.

5.2.1 Site Characterization

The elements of the site characterization have been described in previous sections. Section 3.0 gives a description of the physiography, climate, geology, groundwater, surface water, oceanography, biological habitats, demographics, and land use in the vicinity of Kotzebue LRRS. Section 4.2 describes how the site was divided into four separate investigative areas.

5.2.2 Identification of Exposure Pathways

An exposure pathway describes the route of a contaminant from a contaminated source to a potentially exposed individual. Five factors were considered in the evaluation of potential exposure pathways at Kotzebue LRRS:

- Sources of chemicals of potential concern
- Impacted media (e.g., surface soil)
- A contact point with the impacted medium (e.g., airborne soil particulates)
- A potential route for chemical intake by a human receptor (e.g., inhalation)
- A potential human receptor.

The purpose of identifying exposure pathways at Kotzebue LRRS was to determine which humans may be potentially exposed to detected contaminants at the Kotzebue LRRS site and what exposure pathways may pose the greatest potential for chemical exposure.

5.2.2.1 Contaminant Sources. The primary sources of contaminants at Kotzebue LRRS are due to the use, disposal, and spillage of diesel fuel. Pesticides have also been used previously at the site for insect control. Storage tanks, a contaminated landfill, and contaminated buildings presently remain on site. The soils, sediments, groundwater, and surface waters affected by these past activities have been sampled and have been shown to be potential secondary sources of concern. Chemicals of potential concern include volatile and semi-volatile organic compounds, pesticides/PCBs, and metals (see Table 5-1).

5.2.2.2 Fate and Transport Within Contaminated Media. Four environmental media were sampled at Kotzebue LRRS: soil, sediment, groundwater, and surface water. Each media demonstrated detectable concentrations of various chemicals of concern. Chemical contaminants can potentially migrate from the contaminated source to other environmental media, depending on their migration capacities. The potential for migration in soil, surface water, or groundwater is limited due to the permafrost conditions at Kotzebue LRRS. However, during break-up, soil and surface water contaminants may become mobile due to rainfall infiltration and migrate via surface water runoff towards Kotzebue Sound (for West Drainage) or into the lake (for East Drainage). Contaminants carried in runoff may settle into the sediments or may remain in solution, thereby creating the potential to become absorbed by a plant or animal species and bioaccumulate into the food chain. Soil or surface water contaminants may also become

volatile during the summer season, causing the contaminant to enter into the atmosphere. By these mechanisms, chemicals may move between several environmental media.

5.2.2.3 Exposure Points. An exposure pathway is complete when there is a point at which chemical uptake or intake by a receptor may occur. An example of an exposure point at the Kotzebue LRRS is the location at which the maximum soil concentration of PCBs was detected [Site SS16 (AOC6-Navigational Aid Buildings)], because persons may readily contact the contaminants in the soils at that location.

5.2.2.4 Exposure Routes. Potential chemical exposure could occur by direct ingestion of contaminated soils, sediments, or surface waters; inhalation of contaminated airborne dust; inhalation due to volatilization; or dermal contact with contaminated soils, sediments, or surface waters. Potential exposure could also occur through the consumption of contaminated terrestrial or aquatic organisms and vegetation.

5.2.2.5 Potential Human Receptors. Several population groups represent potentially exposed human receptors for the Kotzebue LRRS, including:

- Radar maintenance technician
- Recreational users
- Subsistence users

A single radar technician (housed in the city of Kotzebue) maintains the active radar dome facility at Kotzebue LRRS. In addition, USAF personnel and radar maintenance technicians service the installation on a periodic basis. Potential recreational users (adults and children) include: ATV use on roads and beach areas, beach combing and summer picnicking along beach areas, and recreational hunting and fishing. Subsistence use by adults and children may include berry picking in adjacent wetlands, terrestrial hunting along the tundra hill and surrounding area, and marine hunting and fishing in Kotzebue Sound and along the beach area.

5.2.3 Description of Exposure Pathways

A complete exposure pathway consists of a contaminant, a receptor contact, and a route for the uptake of the contaminant of concern. The following sections present a qualitative screening of the potential

exposure pathways at the Kotzebue LRRS, including soil, air, groundwater, surface water, sediment, and food.

5.2.3.1 Soil Exposure Pathway. Chemicals of potential concern have been detected in surface soils at the Kotzebue LRRS. Recreational and subsistence users of the Kotzebue LRRS site, which include berry pickers, picnickers, hunters, and fisherman, have the potential to be exposed to chemicals detected in soils by incidental soil ingestion or dermal contact. Because surface soils are typically frozen for eight months of the year, it is assumed that exposure to chemicals of concern in the soil would occur only during the 120 days of the summer months. Soil exposure was considered to be a potential exposure pathway and a quantitative risk evaluation was performed.

5.2.3.2 Air Exposure Pathway. Because recreational and subsistence users of the Kotzebue LRRS site can be potentially exposed to chemicals of concern via inhalation, the two air exposure pathways by which chemicals may reach the atmosphere were evaluated for Kotzebue LRRS: 1) airborne particulates (dust) from surface soils, or 2) volatilization from surface soils or waters. For this contaminant pathway, soil contaminant data for the entire site (i.e., all terrestrial investigative areas) were pooled to derive the EPC. Because surface soils are typically frozen for eight months of the year, the potential for dust emissions or volatilization from soil was assumed to be limited to four months annually. Particulate emissions due to wind erosion from contaminated areas is dependent upon local wind speeds and the erodibility of surface soils. The average wind speed for the Kotzebue area is relatively high during the summer months (12.9 mph), with the prevailing wind direction out of the east-southeast. However, precipitation is the highest during this season. In combination, these factors generally limit the potential for dust in soil. Volatilization of chemicals of concern is dependent upon their volatilization potential (V_p). Chemicals with a V_p less than $2.4E-7$, which includes pesticides, inorganics, and some semi-volatile organics, do not generally volatilize into the environment (Wang and Jones 1994). Exposure to chemicals in air was considered to be a potential exposure pathway and a quantitative risk evaluation was performed.

The potential for volatilization from two surface water areas, including the lake and Kotzebue Sound, exist at the Kotzebue LRRS. Surface water samples at the lake included only one detected pesticide, heptachlor epoxide, which has a V_p less than $2.4E-7$ and is not considered readily volatile. In Kotzebue Sound, detected chemicals included: DDD, DDE, DDT, and some inorganics (arsenic, calcium, potas-

sium, and magnesium). DDD, DDE, and DDT each have a V_p less than $2.4E-7$, and along with inorganics, are not considered readily volatile. For this baseline human health risk assessment, volatilization of chemicals from these surface waterbodies was considered to be of low significance and was not evaluated.

5.2.3.3 Groundwater Exposure Pathway. Groundwater must reach the surface in order for humans to contact chemicals of potential concern. Two possible mechanisms exist by which groundwater may reach the surface: 1) pumping for use as a potable water supply, or 2) discharge to surface waterbodies. The potential exposure pathways for humans include: ingestion of water, dermal contact with water, or inhalation of chemicals volatilized from water. The potable water supply for the Kotzebue LRRS site comes from the City of Kotzebue. Therefore, ingestion of groundwater is not a potential exposure pathway. The local groundwater flow is estimated to be to the southwest, towards Kotzebue Sound. Groundwater associated with the beach area at Kotzebue LRRS is restricted to a narrow zone adjacent to Kotzebue Sound, where the depth to permafrost (undetermined) is sufficiently depressed by marine influence to support a continuously saturated subsurface zone. Groundwater was not detected at a depth of 10 ft below ground surface along the base of the tundra hill, based on a single soil boring installed during the Stage 1 RI/FS. Due to the climatic conditions in Kotzebue and the geological conditions which minimize the likelihood of groundwater surfacing, dermal contact with groundwater and inhalation due to volatilization were considered to be exposure pathways of low significance and were not evaluated.

5.2.3.4 Surface Water Exposure Pathway. Surface water runoff originating from the installation is topographically directed either west towards Kotzebue Sound or east towards nearby wetlands and the lake. The lake and Kotzebue Sound are two areas for potential human exposure to surface waters at the Kotzebue LRRS. Possible exposure pathways include: dermal contact with surface waters, incidental ingestion of surface waters, and inhalation of chemicals volatilized from water.

Volatilization of chemicals of concern from surface waters was considered to be a pathway of low significance due to the relatively low number of chemical detections and their relatively low volatilization potential. Dermal contact with and ingestion of surface waters would most likely occur along the beachfront or at the lake during recreational activities (e.g., swimming, picnicking, or berry picking). Both pathways were considered of potential significance for human exposure and a quantitative exposure and risk evaluation was performed.

5.2.3.5 Sediment Exposure Pathway. Based on sediment samples collected from the lake, sediments represent another medium of possible exposure to site contaminants. Potential human exposure could occur via dermal contact with sediments or accidental ingestion of sediments. Exposure could occur during recreational activities (e.g., swimming, picnicking, or berry picking). Therefore, dermal exposure and ingestion of sediments in the lake were considered potential exposure pathways and a quantitative exposure and risk evaluation was performed.

5.2.3.6 Food Exposure Pathway. Ingestion of food items that come in contact with contaminants at Kotzebue LRRS may represent an indirect mode of chemical exposure. Plants growing at the site in contaminated soils (such as berries or root plants) could potentially accumulate contaminants through root uptake and store them in their roots and other edible portions of the plant. Marine mammals and fish may be exposed to contaminated surface waters in Kotzebue Sound. Some contaminants have the potential to bioaccumulate through the food chain and bioconcentrate in a particular organism. Humans can receive secondary exposure upon ingestion of either a contaminated plant or exposed organisms. Land mammals that graze upon contaminated soils and vegetation at Kotzebue LRRS also have the potential to accumulate contaminants which, upon human ingestion, may be an indirect pathway for exposure. Therefore, exposure to chemicals through ingestion of contaminated food was considered a potential exposure pathway and a quantitative risk evaluation was performed.

In 1992, the Alaska Department of Fish and Game performed a survey of subsistence activities in the Kotzebue community (Fall and Utermohle 1993). Of those surveyed, 73.8% participated in at least one subsistence harvest activity. The top three subsistence activities included: gathering wild plants (61%), fishing (53%), and hunting (36%). The Alaska Department of Fish and Game derived a representative amount harvested per capita for popular fish, game, and plant resources in the Kotzebue Sound area (Fall and Utermohle 1993). Appendix C contains a summary of these data and relative percentages for species harvested in the Kotzebue area.

A conservative approach was taken to determine representative target species and consumption rates for assessing potential chemical exposure via the food ingestion pathway for the Kotzebue subsistence community. For the purposes of this quantitative exposure assessment, the amount harvested per capita was used as an estimate of consumption rates reflective of the community's culture and lifestyle. Equating per capita harvest with consumption rate is a conservative assumption because often only a portion of the

organism is consumed and harvested prey may be traded or sold to other individuals. The most popular species, as defined by the relative percent harvested, were selected as representative target species:

Species	Pounds Harvested (per capita)	% of Total of Harvested Resource (Resource classification)
Chum Salmon	73.07	12.4 (salmon)
Sheefish	116.93	19.8 (non-salmonids)
Caribou	140.98	23.9 (big game)
Bearded Seal	110	18.7 (marine mammals)
Berries	14.85	2.5 (plants & berries)

5.2.4 Quantification of Exposure Assessment

Exposure is proportional to the chemical concentration detected in the contaminated medium and depends upon the rate of contact, the duration of exposure, and other site and receptor specific characteristics. The intake factor (IF), which is calculated from these parameters, is multiplied by the detected concentration (EPC; see Section 5.1.2) in order to determine an exposure intake concentration. Specific values and assumptions used in estimating exposures were based on U.S. EPA (1989a, 1990a, 1991a, 1992a) guidance.

The following sections show the algorithms used to calculate the intake factors for the potential human exposure pathways at the Kotzebue LRRS (Figure 5-1). All quantitative intake values can be found in Appendix C.

5.2.4.1 Inhalation Exposure. Exposure to volatile chemicals and fugitive dust via inhalation was calculated using the following formula:

$$\text{Intake (mg/kg/day)} = \frac{C_a \times IR \times EXT \times EF \times ED}{BW \times AT} \quad (\text{Equation 5-1})$$

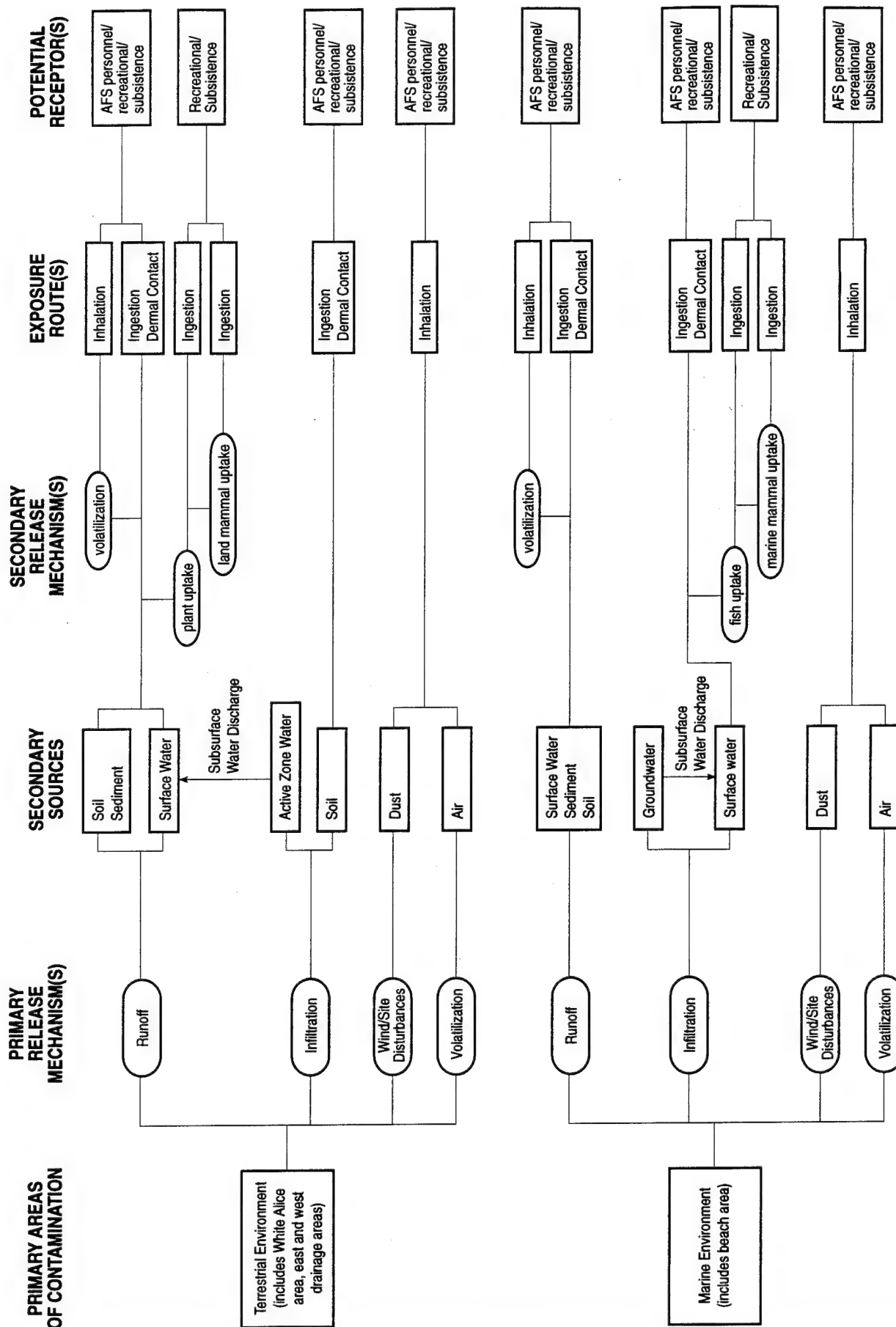


Figure 5-1. Human Health Exposure Pathways Evaluated for Kotzebue LRRS, Alaska.

where:

C_a	=	Concentration in air (mg/m ³)	
IR	=	Inhalation rate (m ³ /day)	= 20 (adults)/12 (children)
EXT	=	Exposure time (fraction of day)	= 0.5
EF	=	Exposure frequency (days/year)	= 120
ED	=	Exposure duration (years)	= 18 (adults)/6 (children)
BW	=	Body weight (kg)	= 70 (adults)/15 (children)
AT	=	Averaging time for pathway specific exposure period (ED x 365 days/year for noncarcinogens and 70 years x 365 days/year for carcinogens).	

The values used for each of these exposure parameters are shown in Table 5-2. Both adult and child exposures were considered. The inhalation rates assumed for adults and children were taken from U.S. EPA (1990a, 1994e) guidance. The exposure frequency assumed that recreational and subsistence activities on the site will occur primarily during the four-month period of the summer thaw. The exposure duration for adults was estimated using data provided in a 1992 survey of demographic characteristics of households in Kotzebue (Fall and Utermohle 1993). The exposure duration for children and body weights of adults and children were based on U.S. EPA (1989a) guidance.

5.2.4.1.1 Fugitive Dust. Chemical-specific concentrations of dust in air were estimated by first calculating the EPC for all COPCs in soil (all site soil samples were pooled for this calculation) and then dividing by a particulate emission factor (PEF).

$$C_{air} = \frac{C_{soil}}{PEF} \quad \text{(Equation 5-2)}$$

A site-specific PEF value of 838,298 m³/kg was calculated using the following equation (Cowherd et al. 1985):

TABLE 5-2. VALUES USED IN ASSESSING EXPOSURE AT KOTZEBUE LRRS
(Page 1 of 2)

Parameter	RME Value	Source/Rationale
General Parameters		
Body Weight (BW) Adult Child	70 kg 15 kg	U.S. EPA, 1990a
Exposure Frequency (EF)	120 days/year	Based upon climatic data from the U.S. Dept. of Commerce Comparative Climatic Data for the United States, 1986
Exposure Duration (ED) Adult Child	18 years 6 years	Mean length of residency, based upon 1992 census for Alaska Department of Fish and Wildlife (Fall & Utermohle, 1993)
Averaging Time (AT) Carcinogen Noncarcinogen	70 years x 365 days/year ED x 365 days/year	U.S. EPA, 1989a U.S. EPA, 1989a
Pathway Specific Parameters		
Particulate and Volatile Inhalation		
Inhalation Rate (IR) Adult Child	20 m ³ /day 12 m ³ /day	U.S. EPA, 1991a U.S. EPA Region III, 1994
Exposure Time (EXT)	0.5	Assumes all day exposure, based upon best professional judgement
Soil/Sediment Ingestion		
Soil Ingestion Rate (IR) Adult Child	100 mg/day 200 mg/day	U.S. EPA, 1991a
Fraction Ingested (FI)	1	Assumes complete ingestion
Soil/Sediment Dermal Contact		
Skin Surface Area (SS) Adult Child	5,000 cm ² 1,980 cm ²	U.S. EPA, 1992a (Assumes 25% of total skin exposed including: head, hands, forearms and lower legs).
Soil Adherence Factor (AF)	1 mg/cm ² /day	U.S. EPA, 1992a
Absorption Factor (ABS)	Depends on chemical category (%)	U.S. EPA, 1992a

TABLE 5-2. VALUES USED IN ASSESSING EXPOSURE AT KOTZEBUE LRRS
(Page 2 of 2)

Parameter	RME Value	Source/Rationale
Surface Water Dermal Contact		
Skin Surface Area (SS) Adult Child	20,000 cm ² 7,930 cm ²	U.S. EPA, 1992a 50 Percentile for child of age 6
Dermal Permeability Constant (PC)	Chemical Specific (cm/hour)	U.S. EPA, 1992a
Exposure Time (ET)	1.0 hours/day	U.S. EPA, 1992a
Surface Water Ingestion		
Exposure Time (ET)	1.0 hours/day	U.S. EPA, 1992a
Ingestion Rate (IR) Adult/Child	0.08 L/hour	U.S. EPA, 1990a
Ingestion Rates of Animals and Plants for Subsistence Uses		
Chum Salmon Sheefish Bearded Seal Caribou Wild Berries	90.85 g/day 145.4 g/day 137.8 g/day 175.3 g/day 18.5 g/day	Based on amount harvested per capita (Fall and Utermohle, 1993)
Exposure Frequency for Consumption of Food		
Exposure Frequency	365 days/year	Based on the knowledge that subsistence users hunt, fish or berry pick yearround, and may freeze or store their catch for annual consumption.

$$PEF(m^3/kg) = \frac{LS \times V \times DH \times T}{A} \times \frac{CF}{RF \times (1-g) \times (U_m/U_t) \times F} \quad (\text{Equation 5-3})$$

where:

LS	=	Width of contaminated area (m)	=	914.4
V	=	Wind speed in mixing zone (m/sec)	=	2.89
DH	=	Diffusion height (m)	=	0.4
T	=	Time in an hour (sec/hour)	=	3,600
A	=	Area of contamination (m ²)	=	735,768
CF	=	Conversion factor (1000 g/kg)	=	1,000
RF	=	Respirable fraction (g/m ² -hour)	=	0.036
g	=	Fraction of vegetative cover	=	0.80
U _m	=	Mean annual wind speed (m/sec)	=	5.77
U _t	=	Equivalent threshold value of wind speed at 10m (m/sec)	=	7
F	=	Function dependent on U _m /U _t (unitless)	=	1.53

The width (LS) and area (A) of the site were determined from aerial photographs. These values represent the entire site because it was assumed that an individual could potentially be exposed to airborne chemicals and dust from soil located anywhere on the site. The mean annual wind speed (U_m) at the site was calculated from monthly averages measured at the City of Kotzebue (U.S. Department of Commerce 1986). Wind speed in the mixing zone (V) was estimated to be one-half the mean annual wind speed (U.S. EPA 1991b). The fraction of vegetative cover (g) was estimated during the collection of field samples during July 1994. The equivalent threshold value of wind speed at 10 m (U_t) was estimated using equations presented in Cowherd et al. 1985 for a particle diameter of 0.015 mm, which is characteristic of fine to medium sands. This particle size is the mode for soil samples collected at the Kotzebue LRRS. The value of F was also calculated using the methodology presented in Cowherd et al. (1985). Values assumed for all other parameters are consistent with risk assessment guidance provided in U.S. EPA (1989a).

5.2.4.1.2 Volatilization. The potential for a chemical to volatilize can be assessed by calculating its volatilization potential (Vp), which can be estimated by dividing the Henry's law constant (H) by the

chemical-specific organic carbon partition coefficient (Koc) (Wang and Jones 1994). Chemicals with VP values less than $2.4\text{E-}7 \text{ atm-L mole}^{-1}$ (25°C) are considered not to volatilize from soil (Wang and Jones 1994). This includes pesticides/PCBs, volatile organic chemicals, and most semi-volatile organic chemicals. For chemicals with Vp values greater than $2.4\text{E-}7 \text{ atm-L mole}^{-1}$, air concentrations were estimated from the following equation using the 95% UCL (all site soil samples were pooled for this calculation) for soil concentrations (C_{soil}):

$$C_{\text{air}} = \frac{C_{\text{soil}}}{VF} \quad (\text{Equation 5-4})$$

The value of the volatilization factor (VF) in the above equation was estimated using the following equations (U.S. EPA 1991b):

$$VF(\text{m}^3/\text{kg}) = \frac{LS \times V \times DH}{A} \times \frac{(3.14 \times \alpha \times T)^{0.5}}{2 \times D_{ei} \times E \times K_{as} \times CF} \quad (\text{Equation 5-5})$$

and

$$\alpha(\text{cm}^2/\text{s}) = \frac{(D_{ei} \times E)}{E + \frac{(P_s)(1-E)}{K_{as}}} \quad (\text{Equation 5-6})$$

where:

LS	=	Width of contaminated area (m)	=	914.4
V	=	Wind speed in mixing zone (m/sec)	=	2.89
DH	=	Diffusion height (m)	=	0.4
A	=	Area of contamination (cm^2)	=	735,768
T	=	Exposure interval (s)	=	3,600
D_{ei}	=	Effective diffusivity (cm^2/sec) ($D_i \times E$)	=	Chemical/specific
E	=	True soil porosity (unitless)	=	0.35
D_i	=	Molecular diffusivity (cm^2/sec)	=	Chemical/specific

CF	=	Conversion factor (10^{-3} kg/g)	=	0.001
p_s	=	True soil density or particulate density (g/cm ³)	=	1.89
K_{as}	=	Soil/air partition coefficient (g soil/cm ³ air) (H/K_d)	=	Chemical/specific
H	=	Henry's law constant (atm-m ³ /mol)	=	Chemical/specific
K_d	=	Soil-water partition coefficient (cm ³ /g) ($K_{oc} \times OC$)	=	Chemical/specific
K_{oc}	=	Organic carbon partition coefficient (cm ³ /g)	=	Chemical/specific
OC	=	Organic carbon content of soil (fraction)	=	0.0398

Site-specific parameters (LS, V, DH, A) were estimated as described in Section 5.2.4.1.1. Chemical-specific molecular diffusivities (D_i) were obtained from Dragun (1988). Soil density (p_s) and soil organic carbon content (OC) are mean values measured for samples collected on site. The value for true soil porosity was obtained from U.S. EPA (1991b).

5.2.4.2 Incidental Ingestion of Soil. Ingestion of soil particulates occurs by the accidental ingestion of particles present on hands, edible plants grown in a contaminated area, or by swallowing particles collected in the nasal passages. The level of exposure depends on the chemical concentrations in soil, the amount ingested, and the frequency and duration of exposure. Exposures for adults and children were evaluated. U.S. EPA has determined that children may receive higher levels of exposure from soil contact due to their higher ingestion rate and may also be more sensitive to the effects of chemical exposures than adults.

Exposure via soil ingestion was calculated using the following equation:

$$Intake \text{ (mg/kg/day)} = \frac{C_s \times C_f \times FI \times IR \times EF \times ED}{BW \times AT} \quad (\text{Equation 5-7})$$

where:

C_s	=	Concentration in soil (mg/kg)	=	EPC
C_f	=	Conversion factor for chemical fraction of soil (kg to mg)	=	10^{-6}

FI	=	Fraction ingested from contaminated source	=	1
IR	=	Ingestion rate (mg/day)	=	100 (adults)/200 (children)
EF	=	Exposure frequency (days/year)	=	120
ED	=	Exposure duration (years)	=	18 (adults)/6 (children)
BW	=	Body weight (kg)	=	70 (adults)/15 (children)
AT	=	Averaging time for pathway specific exposure period (ED x 365 days/year for noncarcinogens and 70 years x 365 days/year for carcinogens).		

The specific values for each of these exposure parameters are shown in Table 5-2. The rationale for the values assumed for EF, ED, BW, and AT is discussed in Section 5.2.4.1. It was assumed that 100 percent of ingested soil was from the Kotzebue site (i.e., FI = 1). Soil ingestion rates for adults and children are consistent with risk assessment guidance provided in U.S. EPA (1989a).

5.2.4.3 Dermal Contact with Soil or Sediments. Chemical exposure can occur when dermal surfaces contact soils (or sediments), with subsequent absorption through the skin. Chemical exposure by dermal contact is a function of the chemical concentration in the soil, the skin area exposed, the amount of soil adhering to the skin, and the fraction of chemical absorbed through the skin.

Exposure via dermal soil and sediment contact was calculated using the following equation:

$$Intake \text{ (mg/kg/day)} = \frac{C_s \times CF \times SS \times AF \times ABS \times EF \times ED}{BW \times AT} \quad (\text{Equation 5-8})$$

where:

C_s	=	Concentration in soil (mg/kg)	=	EPC
CF	=	Conversion factor for chemical fraction of soil	=	10^{-6}
SS	=	Exposed skin surface area (cm ²)	=	5000 (adults)/1980 (children)
AF	=	Soil adherence factor (mg/cm ²)	=	1
ABS	=	Chemical absorption fraction	=	Chemical-specific
EF	=	Exposure frequency (days/year)	=	120
ED	=	Exposure duration (years)	=	18 (adults)/6 (children)

BW = Body weight (kg) = 70 (adults)/15 (children)
 AT = Averaging time for pathway specific exposure period (ED x 365 days/year for noncarcinogens and 70 years x 365 days/year for carcinogens).

The specific values for each of these exposure parameters are shown in Table 5-2. The rationale for the values assumed for EF, ED, BW, and AT is discussed in Section 5.2.4.1. Twenty-five percent of total body surface area was used as exposed skin surface area (SS) (U.S. EPA 1992a). The soil adherence factor (AF) assumed 1.0 mg per cm² of exposed surface per day (U.S. EPA 1992a).

The chemical absorption fraction (ABS) depends upon the bioavailability of the chemical in the soil or sediment matrix, which is a factor of several soil and chemical characteristics, including the percentage of water in the soil and the chemical's water solubility. Additionally, as the skin is an effective barrier to many compounds, exposure is dependent upon the soil to skin partition coefficient, which depends upon the chemical's lipophilicity and size, and the skin's thickness and exposed surface area. Chemical absorption fraction (ABS) values for chemical classes (California EPA 1994) were used to assign values for specific chemicals. ABS values assumed for chemical classes were: chlorinated insecticides (0.05), polycyclic aromatic hydrocarbons (0.15), PCBs (0.15), dioxins and furans (0.03), other organic compounds (0.10), cadmium (0.001), arsenic (0.03), and other inorganics (0.01).

5.2.4.4 Dermal Contact with Surface Water. Chemical exposure can occur via dermal contact with surface water. At Kotzebue LRRS, recreational and subsistence fishers, beach combers, and picnickers have the potential to be exposed to contaminants in Kotzebue Sound or at the lake. The level of potential chemical exposure by dermal contact is a function of the chemical concentration in the surface water, the area of skin exposed, the permeability of the skin to the chemical, the exposure time, the body weight of the individual exposed, and the exposure frequency and duration. Additionally, a dermal permeability coefficient, which is a function of the chemical's octanol-water partition coefficient and molecular weight, is a multiplier in this equation.

Exposure via dermal contact with surface water was calculated using the following equation:

$$Intake \text{ (mg/kg/day)} = \frac{C_w \times CF \times SA \times ET \times EF \times ED \times P_c}{BW \times AT} \quad \text{(Equation 5-9)}$$

where:

C_w	=	Concentration in water (ug/L)	=	EPC
CF	=	Conversion factor (mg/ug x L/cm ³)	=	10 ⁻⁶
SA	=	Exposed skin surface area (cm ²)	=	20,000 (adults)/7,930 (children)
ET	=	Exposure time (hours/day)	=	1.0
EF	=	Exposure frequency (days/year)	=	120
ED	=	Exposure duration (years)	=	18 (adults)/6 (children)
P_c	=	Dermal permeability constant (cm/hour)	=	Chemical-specific
BW	=	Body weight (kg)	=	70 (adult)/15 (children)
AT	=	Averaging time for pathway specific exposure period (ED x 365 days/year for noncarcinogens and 70 years x 365 days/year for carcinogens).		

The specific values for each of these exposure parameters are shown in Table 5-2. The rationale for the values assumed for EF, ED, BW, and AT is discussed in Section 5.2.4.1. Both adult and child exposure were considered. Exposed skin surface area for adults and children (50 percent for children at age 6) was in accordance with U.S. EPA (1989a, 1992a) guidance. Exposure time (ET) was in accordance with U.S. EPA (1989a).

5.2.4.5 Ingestion of Surface Water. Ingestion of surface water can occur while a recreational or subsistence user at the Kotzebue site is performing activities where there is the potential for accidental ingestion of surface water. This may include swimming or picnicking along the beachfront area or by the lake. These waterbodies were assessed separately. Intake values were determined using measured surface water concentrations at the lake and in Kotzebue Sound.

Exposure via surface water ingestion was determined using the following equation:

$$Intake \text{ (mg/kg/day)} = \frac{C_w \times C_f \times IR \times ET \times EF \times ED}{BW \times AT} \quad (\text{Equation 5-10})$$

where:

C_w	=	Concentration in water ($\mu\text{g/L}$)	=	EPC
C_f	=	Conversion factor (μg to mg)	=	10^{-3}
IR	=	Ingestion rate (L/hour)	=	0.08
ET	=	Exposure time (hours/day)	=	1.0
EF	=	Exposure frequency (days/year)	=	120
ED	=	Exposure duration (years)	=	18 (adult)/6 (children)
BW	=	Body weight (kg)	=	70 (adult)/15 (children)
AT	=	Averaging time for pathway specific exposure period ($\text{ED} \times 365 \text{ days/year}$ for noncarcinogens and $70 \text{ years} \times 365 \text{ days/year}$ for carcinogens).		

The specific values for each of these exposure parameters are shown in Table 5-2. The rationale for the values selected for EF, ED, BW, and AT is discussed in Section 5.2.4.1. The exposure time (ET) was in accordance with U.S. EPA (1989a) guidance. The ingestion rate for both adults and children was selected in accordance with U.S. EPA (1989a).

5.2.4.6 Ingestion of Fish and Marine Mammals. Ingestion of aquatic animals that have come in contact with contaminants from the Kotzebue LRRS site may represent an indirect mode of chemical exposure. Exposures resulting from ingestion of fish and seal were calculated separately using the following equation:

$$\text{Intake } (\text{mg/ kg / day}) = \frac{C_a \times C_f \times FI \times IR \times EF \times ED}{BW \times AT} \quad (\text{Equation 5-11})$$

where:

C_a	=	Concentration in the aquatic animal (mg/kg)	=	EPC
C_f	=	Conversion factor for chemical fraction in fish (kg to mg)	=	10^{-6}
FI	=	Fraction ingested from contaminated source	=	1

IR	=	Ingestion rate (mg/day)	=	Species specific
EF	=	Exposure frequency (days/year)	=	365
ED	=	Exposure duration (years)	=	18 (adults)/6 (children)
BW	=	Body weight (kg)	=	70 (adults)/15 (children)
AT	=	Averaging time for pathway specific exposure period (ED x 365 days/year for noncarcinogens and 70 years x 365 days/year for carcinogens).		

The specific values for each of these exposure parameters are shown in Table 5-2. Chum salmon, sheefish, and bearded seal comprise 51 percent of the Kotzebue per capita subsistence harvest, and 76 percent of the total subsistence harvest of fish and marine mammals (see Appendix C). Ingestion rates for these species were based upon per capita harvest data (see Section 5.2.3.6). Ingestion rates used for chum salmon, sheefish, and bearded seal were 73.07 lb/year (90.85 g/day), 116.93 lb/year (145.4 g/day), and 110 lb/year (137.8 g/day), respectively. For fish, risk characterization (Section 5.4) was presented only for sheefish because the higher consumption rate yielded more conservative risk estimates. An exposure frequency of 365 days/year was assumed since recreational and subsistence users may fish year round and may freeze and/or store their catch for consumption on an annual basis.

5.2.4.6.1 Calculation of Chemical Concentrations in Fish Tissue. Because no fish samples were analyzed during the 1994 RI, chemical concentrations in fish were derived by multiplying the chemical concentration in water by a chemical-specific bioconcentration factor (BCF). BCF values were obtained from either the National Library of Medicine TOXNET database, scientific literature, or were estimated from the octanol-water partition coefficient (K_{ow}) (Suter 1993) (Table 5-3).

The entire suite of COPCs were not analyzed in surface waters from Kotzebue Sound (only volatile and semivolatile organic compounds were measured in surface water). However, all COPCs were analyzed in groundwater samples collected at two locations within the beach site. To estimate surface water concentrations, a near-field dilution value for groundwater was calculated using a simple compartment model. The model assumed that a volume of groundwater seeps into Kotzebue Sound through the beach. The groundwater is diluted by a volume of seawater that sweeps across the beach. Using a model which estimated the volume flux of groundwater and seawater in the beach area and the magnitude of tidal and wind-induced currents, a dilution value of 2,000,000 was estimated. The derivation of this value is described in greater detail in Appendix D.

TABLE 5-3. BCF, KOW, FCM AND BAF VALUES USED FOR BASELINE HUMAN HEALTH RISK ASSESSMENT

Detected COPCs	fish log BCF	log Kow	FCM	seal log BCF	BAF
4,4'-DDT	4.91	6.36	98.0	4.62	1.57E+07
Benzene	0.64	2.11	1.0	1.27	7.05E+01
Chloroform	0.78	1.9	1.0	1.10	4.81E+01
Naphthalene	3.00	3.36	1.0	2.25	6.85E+02
Xylenes, total	2.20				
bis(2-Ethylhexyl) Phthalate	2.05	4.2	1.1	2.92	3.48E+03

Non-detected COPCs	fish log BCF	log Kow	FCM	seal log BCF	BAF
1,1,2,2-Tetrachloroethane	1.00	2.39	1.0	1.49	1.17E+02
1,1,2-Trichloroethane	*	2.18	1.0	1.32	8.01E+01
1,1-Dichloroethane	*	1.48	1.0	0.77	2.24E+01
1,2,4-Trichlorobenzene	3.11	3.98	1.0	2.74	2.12E+03
1,2-Dichloroethane	*	1.45	1.0	0.75	2.12E+01
1,2-Dichloropropane	1.26	2.28	1.0	1.40	9.61E+01
1,4-Dichlorobenzene	2.86	3.52	1.0	2.38	9.17E+02
2,2'-Oxybis (1-Chloropropane)		2.58	1.0	1.64	1.66E+02
2,4,6-Trichlorophenol	2.49	3.69	1.0	2.52	1.25E+03
2,4-Dichlorophenol	2.00	3.08	1.0	2.03	4.12E+02
2,4-Dinitrophenol	0.91	1.53	1.0	0.81	2.46E+01
2,4-Dinitrotoluene	2.31	2.01	1.0	1.19	5.88E+01
2,6-Dinitrotoluene	1.08	2.01	1.0	1.19	5.88E+01
2-Nitroaniline	1.18			-0.40	0.00E+00
3,3'-Dichlorobenzidine	6.10	3.3	1.0	2.21	6.15E+02
3-Nitroaniline	0.81			-0.40	0.00E+00
4-Chloroaniline	1.30			-0.40	0.00E+00
4-Nitroaniline	1.26			-0.40	0.00E+00
Aldrin	4.03	4.3	1.1	3.00	4.17E+03
Arochlor 1016		5.88	47.0	4.25	3.15E+06
Arochlor 1221		4	1.0	2.76	2.20E+03
Arochlor 1232		4.48	1.2	3.14	6.31E+03
Arochlor 1242		6	67.0	4.34	5.59E+06
Arochlor 1248				-0.40	0.00E+00
Arochlor 1254	5.66	6.48	100.0	4.72	2.00E+07
Arochlor 1260	5.57	6.91	100.0	5.06	4.37E+07
Arsenic				-0.40	0.00E+00
Benzo(a)anthracene	4.04	5.61	16.0	4.03	6.57E+05
Benzo(a)pyrene	2.96	5.98	67.0	4.32	5.39E+06
Benzo(b)fluoranthene	6.50	6.57	100.0	4.79	2.35E+07
Benzo(k)fluoranthene	4.97	6.85	100.0	5.01	3.92E+07
Bromodichloromethane	1.37	2.1		1.26	0.00E+00
Bromoform	1.57	2.3	1.0	1.42	9.97E+01
Bromomethane	0.47	1	1.0	0.39	9.37E+00
Carbon Disulfide	0.90			-0.40	0.00E+00
Carbon Tetrachloride	1.24			-0.40	0.00E+00
Chlorobenzene	2.42	3.79	1.0	2.59	1.50E+03
Chloromethane	*	0.9	1.0	0.31	7.81E+00
Chrysene	4.26	5.61	16.0	4.03	6.57E+05
Dibenzo(a,h)anthracene	4.71	6.5	100.0	4.74	2.07E+07
Dibenzofuran	3.23			-0.40	0.00E+00
Dibromochloromethane	1.47	2.24		1.37	0.00E+00
Dieldrin	3.78	3.49	1.0	2.36	8.68E+02
Heptachlor Epoxide	4.16	4.6	1.3	3.23	8.50E+03
Hexachlorobenzene	4.00	5.47	11.0	3.92	3.50E+05
Hexachlorobutadiene	3.76	4.28	1.1	2.98	4.02E+03
Hexachlorocyclopentadiene	2.65	5.51	11.0	3.95	3.77E+05
Hexachloroethane	2.71	3.93	1.0	2.70	1.93E+03
Indeno(1,2,3-c,d)pyrene		7.66	100.0	5.65	1.71E+08
Methylene Chloride	0.70	1.3	1.0	0.63	1.62E+01
N-Nitrosodi-n-propylamine	1.78	1.31	1.0	0.63	1.65E+01
Nitrobenzene	1.18	1.85	1.0	1.06	4.40E+01
Pentachlorophenol	3.73	5.01	2.6	3.56	3.58E+04
Styrene	*			-0.40	0.00E+00
Tetrachloroethylene (pce)	2.12	2.53	1.0	1.60	1.51E+02
Toxaphene	4.79	3.3	1.0	2.21	6.15E+02
Trichloroethylene (tce)	1.95	2.42	1.0	1.51	1.24E+02
Vinyl Chloride	7.00	0.6	1.0	0.07	4.52E+00
bis(2-Chloroethyl) Ether	1.04	1.12	1.0	0.48	1.17E+01
cis-1,3-Dichloropropene	4.84	1.98	1.0	1.16	5.57E+01
trans-1,3-Dichloropropene	4.84	1.98	1.0	1.16	5.57E+01

The use of near-field dilution represents a conservative approach. Near-field dilution of groundwater occurs immediately adjacent to the beach. Far-field dilution occurs throughout Kotzebue Sound. The key receptor species are likely to be found both inside and outside the area considered to be near-field. The overall dilution of groundwater into Kotzebue Sound, including both near-field and far-field components, is likely to be greater than 2,000,000. As a rough estimate of the potential far-field dilution, the volume of Kotzebue Sound that is mixed daily through tides was calculated to be $1.6 \times 10^9 \text{ m}^3$. Using the groundwater flux volume calculated for the near-field dilution (see Appendix D), there is a potential for an additional 100-fold dilution due to far-field effects. For each COPC, the chemical concentrations in water used to estimate fish tissue concentration was the EPC divided by the near-field dilution value.

The application of BCF values assumes that the flux of contaminants between the animal and the water has reached equilibrium. For chum salmon, and possibly sheefish, this assumption may not be true. Neither species is found adjacent to the beach site year round. An individual chum salmon is not likely to be exposed to contaminants for more than 2 months (during spawning) out of an average life of 4 years (Eschmeyer and Herald 1983, Andrews 1986). Sheefish typically overwinter in the estuarine environment near the beach site for 6 months each year (Georgette and Loon 1993). Thus, the application of BCF values in this exposure assessment is likely to overestimate the COPC concentration to which fish consumers in the Kotzebue area are exposed.

5.2.4.6.2 Calculation of Chemical Concentrations in Seal Tissue. It was assumed that the contaminant exposure pathway to the seal was due solely to the consumption of contaminated fish. For bearded seals, the dietary exposure pathway is likely to be the only significant route of exposure. Two other potential routes of exposure, ingestion of water and dermal contact, were not considered due to the fact that mammals do not ingest seawater and due to the difficulty in determining the significance of the dermal contact pathway because of the unavailability of seal skin permeability factors and the absence of toxicity data specific to dermal uptake. However, given the thick skin and heavy layer of blubber typical of seals, it is likely that the dermal exposure pathway is of little significance. To reduce the level of uncertainty in the estimated COPC concentration in seal, the estimated COPC concentration in fish (Section 5.2.4.6.1) was not used. Instead, the BCF used to calculate the chemical concentration in seal tissue was predicted based on the chemical-specific K_{ow} as follows:

$$\log \text{BCF} = 0.79 \log K_{ow} - 0.40$$

This BCF was then used in the following equation, which is based on U.S. EPA (1993a) guidance:

$$\text{BAF} = \text{BCF} \left(\frac{29.0}{7.6} \right) \text{FCM}$$

where 29.0 is the percent lipid for the seal (U.S. EPA 1993b), 7.6 is the average percent lipid of animals used to derive the BCF equation (U.S. EPA 1993a), and FCM is a chemical-specific food-chain multiplier which is based on the log K_{ow} (U.S. EPA 1993a). The top trophic level was assumed in selecting the appropriate FCM value (see Table 5-3).

The concentration in seal tissue was then calculated by multiplying the calculated water concentration discussed in Section 5.2.4.6.1 by the BAF.

5.2.4.7 Ingestion of Plants and Berries. Ingestion of possible food items, including plants and berries, which have come in contact with contaminated media at the Kotzebue LRRS site, may represent an indirect mode of human intake exposure. Exposure via plant ingestion was calculated using the following formula:

$$\text{Intake (mg/kg/day)} = \frac{C_p \times FI \times IR \times EF \times ED}{BW \times AT} \quad (\text{Equation 5-12})$$

where:

C_p	=	Concentration in plant (mg/kg)	=	EPC
FI	=	Fraction ingested from contaminated source	=	1
IR	=	Ingestion rate (mg/day)	=	18,500
EF	=	Exposure frequency (days/year)	=	365
ED	=	Exposure duration (years)	=	18 (adults)/6 (children)
BW	=	Body weight (kg)	=	70 (adults)/15 (children)
AT	=	Averaging time for pathway specific exposure period (ED x 365 days/year for noncarcinogens and 70 years x 365 days/year for carcinogens).		

The specific values for each of these exposure parameters are shown in Table 5-2. Berries comprise 3 percent of the Kotzebue per capita subsistence harvest (see Appendix C). The ingestion rate assumed for berries of 14.85 lb/year (18.5 g/day), is based upon per capita harvest data (see Section 5.2.3.6). The berry picking locations are indicated on Figures 4-2, 4-4, and 4-5. It was assumed that 100 percent of ingested berries were collected on the Kotzebue LRRS. Exposure frequency was considered to be 365 days/year since canning, freezing, or storing the berries may allow consumption to occur throughout the year. The rationale for the values assumed for ED, BW, and AT is discussed in Section 5.2.4.1.

Root uptake of chemicals of potential concern was evaluated in a two step process. First, the COPCs were screened to eliminate chemicals that have low potential for plant uptake. In the second step, chemical concentrations in plant tissue for COPCs that were not excluded by this screening step, were estimated using an algorithm that predicts plant stem concentrations based on chemical concentrations in soil, surface water and organic carbon content, soil bulk density, and the octanol-water partition coefficient.

The initial screening of COPCs for plant uptake was based on the magnitude of soil/water partition coefficients (K_d) for these chemicals. This coefficient (K_d), can be estimated by $k_{oc} \times f_{oc}$, where k_{oc} is the organic carbon partition coefficient and f_{oc} is the fraction of organic carbon in soil (Wang and Jones 1994). Chemicals with K_d values greater than 1,000 are generally thought to be unavailable for plant uptake because they are strongly sorbed to organic matter (Wang and Jones 1994). In the screening process, COPCs with K_d values greater than 1,000 were excluded from further assessment for plant uptake. COPCs that were excluded during this screening step included benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chlordane and isomers, chrysene, DDT and isomers, fluoranthene, and pyrene.

The concentration of COPCs in soil, which were not excluded in the screening process, were multiplied by a stem concentration factor (SCF) to estimate the uptake and bioavailability of contaminants in plants found at the site. The chemical specific SCF was based upon the following equation (Wang and Jones 1994; Briggs et al. 1982, 1983):

$$SCF = \frac{C_{stem}}{C_{soil}} = \left[\delta / (\delta K_{ow} f_{oc} + \theta) \right] \left[10^{(0.951 \log K_{ow} - 2.05)} + 0.82 \right] \left\{ 0.784 \exp - [(\log K_{ow} - 1.78)^2 / 2.44] \right\}$$

(Equation 5-13)

where:

C_{stem}	=	Chemical concentration in the stem ($\mu\text{g/kg}$)	=	Calculated
C_{soil}	=	Chemical concentration in the soil ($\mu\text{g/kg}$)	=	EPC
K_{ow}	=	Octanol-water partition coefficient	=	Chemical-specific
f_{oc}	=	Fraction of organic carbon	=	0.0398
δ	=	Soil bulk density (g/cm^3)	=	1.89
θ	=	Soil-water content by volume (mL/cm^3)	=	0.336

Chemical-specific K_{ow} values were obtained from U.S. EPA (1989c). Site-specific values for f_{oc} , δ , and θ were calculated from tundra and fill samples collected during the 1994 sampling efforts at Kotzebue LRRS. Plant stem concentrations (C_{stem}) were calculated by multiplying SCF by the EPC C_{soil} value for each study area (Table 5-4).

5.2.4.8 Ingestion of Land Mammals. Ingestion of land animals that have come in contact with the Kotzebue LRRS site may also represent an indirect mode of chemical exposure. Caribou comprise 24 percent of the Kotzebue per capita subsistence harvest, and 80 percent of the total subsistence harvest of terrestrial animals (see Appendix C). Human exposure to chemicals from ingestion of caribou was calculated using the following equation:

$$\text{Intake } (\text{mg/kg/day}) = \frac{C_a \times C_f \times FI \times IR \times EF \times ED}{BW \times AT} \quad (\text{Equation 5-14})$$

where:

C_a	=	Concentration in caribou (mg/kg)	
C_f	=	Conversion factor for chemical fraction in land mammals (kg to mg)	= 10^{-6}
FI	=	Fraction ingested from contaminated source	= 1
IR	=	Ingestion rate (mg/day)	= 175,300
EF	=	Exposure frequency (days/year)	= 365

TABLE 5-4. KOW, BTF, AND SCF VALUES USED FOR THE HUMAN HEALTH BASELINE RISK ASSESSMENT

Detected COPCs	log Kow	log BTF	SCF
2,4-Dinitrotoluene	2.01E+00	-5.59E+00	2.79E-01
2,6-Dinitrotoluene	2.01E+00	-5.59E+00	2.79E-01
2-Nitroaniline		-7.60E+00	8.15E-01
4,4'-DDD	5.99E+00	-1.61E+00	*
4,4'-DDE	5.69E+00	-1.91E+00	*
4,4'-DDT	6.19E+00	-1.41E+00	*
Aldrin	4.30E+00	-3.30E+00	8.06E-03
Arochlor 1254	6.48E+00	-1.12E+00	9.89E-06
Arochlor 1260	6.91E+00	-6.90E-01	6.04E-07
Arsenic			
Benzo(a)anthracene	5.61E+00	-1.99E+00	*
Benzo(a)pyrene	5.98E+00	-1.62E+00	*
Benzo(b)fluoranthene	6.57E+00	-1.03E+00	*
Beryllium			
Chrysene	5.61E+00	-1.99E+00	*
Dieldrin	3.49E+00	-4.11E+00	3.72E-02
Heptachlor	5.05E+00	-2.55E+00	1.24E-03
Heptachlor Epoxide	4.60E+00	-3.00E+00	4.03E-03
Thallium			
alpha BHC	3.81E+00	-3.79E+00	2.15E-02
beta BHC	3.80E+00	-3.80E+00	2.19E-02
* = Kd > 1000, will not be taken up by plants			

Non-detected COPCs	log Kow	log BTF	SCF
1,1,2,2-Tetrachloroethane	2.39E+00	-5.21E+00	1.69E-01
1,1-Dichloroethene	1.48E+00	-6.12E+00	5.74E-01
1,4-Dichlorobenzene	3.52E+00	-4.08E+00	3.55E-02
2,2'-Oxybis (1-Chloropropane)		-7.60E+00	8.15E-01
2,4,6-Trichlorophenol	3.69E+00	-3.91E+00	2.67E-02
3,3'-Dichlorobenzidine	3.30E+00	-4.30E+00	5.00E-02
3-Nitroaniline		-7.60E+00	8.15E-01
4-Nitroaniline		-7.60E+00	8.15E-01
Antimony		-7.60E+00	8.15E-01
Arochlor 1016	5.88E+00	-1.72E+00	9.21E-05
Arochlor 1221	4.00E+00	-3.60E+00	1.50E-02
Arochlor 1232	4.48E+00	-3.12E+00	5.36E-03
Arochlor 1242	6.00E+00	-1.60E+00	6.04E-05
Arochlor 1248		-7.60E+00	8.15E-01
Benzo(k)fluoranthene	6.85E+00	-7.50E-01	2.16E-06
Bromodichloromethane		-7.60E+00	8.15E-01
Carbon Tetrachloride		-7.60E+00	8.15E-01
Dibenzo(a,h)anthracene	6.50E+00	-1.10E+00	9.13E-06
Hexachlorobenzene	5.47E+00	-2.13E+00	3.57E-04
Hexachlorobutadiene	4.28E+00	-3.32E+00	8.42E-03
Hexachloroethane	3.93E+00	-3.67E+00	1.72E-02
Indeno(1,2,3-c,d)pyrene	7.66E+00	6.00E-02	5.19E-08
Isophorone	1.70E+00	-5.90E+00	4.28E-01
N-Nitrosodi-n-propylamine	1.31E+00	-6.29E+00	7.06E-01
N-Nitrosodiphenylamine	3.13E+00	-4.47E+00	6.39E-02
Nitrobenzene	1.85E+00	-5.75E+00	3.48E-01
Pentachlorophenol	5.01E+00	-2.59E+00	1.39E-03
Toxaphene	3.30E+00	-4.30E+00	5.00E-02
Vinyl Chloride	6.00E-01	-7.00E+00	1.12E+00
bis(2-Chloroethyl) Ether	1.12E+00	-6.48E+00	8.62E-01
bis(2-Ethylhexyl) Phthalate	5.30E+00	-2.30E+00	6.02E-04
cis-1,3-Dichloropropene		-7.60E+00	8.15E-01
trans-1,3-Dichloropropene		-7.60E+00	8.15E-01

ED	=	Exposure duration (years)	=	18 (adults)/6 (children)
BW	=	Body weight (kg)	=	70 (adults)/15 (children)
AT	=	Averaging time for pathway specific exposure period (ED x 365 days/year for noncarcinogens and 70 years x 365 days/year for carcinogens).		

The specific values for each of these exposure parameters are shown in Table 5-2. To be conservative, it was assumed that there was 100% ingestion of caribou (FI=1) which were exposed to contaminants present at Kotzebue LRRS. An ingestion rate of 141 lb/year (175.3 g/day) of caribou was assumed based upon per capita consumption data for the City of Kotzebue (see Appendix C). An exposure frequency of 365 days/year was assumed since subsistence users may hunt, freeze, or store their catch for consumption throughout the year.

Caribou which migrate through the Baldwin Peninsula for the winter months, are typically found in the Kotzebue area at the start of break-up and in September, when beginning their southern descent. Because caribou are browsers and not grazers, exposure to contaminants may typically occur through the ingestion of plants and not soils, as they do not include any soils in their diet. By using a food-chain model and assuming that caribou ingest only contaminated plants from the Kotzebue LRRS during the seasonal migratory period and are therefore in equilibrium with the contaminant concentrations, concentrations in caribou were calculated. The food chain model calculated the concentration of contaminants in caribou by considering the chemical concentration in plants, the estimated quantity of plants that caribou consume, and calculated biotransfer factors (BTF) (U.S. EPA 1990b). BTF values (see Table 5-4) for organic compounds are directly proportional to the chemical-specific octanol-water partition coefficient (K_{ow}) using the following equation (U.S. EPA 1990b):

$$\log BTF = -7.6 + \log K_{ow}$$

The concentration in caribou tissue was then calculated using the following equation (U.S. EPA 1990b):

$$C_a = (Q_p \times C_p) \times BTF_a \quad \text{(Equation 5-15)}$$

where:

Q_p	=	Quantity of plants ingested by caribou (kg/day)	=	3.55
C_p	=	Concentration of the analyte in the plant (mg/kg)	=	Calculated
BTF	=	Biotransfer factor (days/kg)	=	Calculated

The quantity of plants ingested by caribou was estimated from Suter (1993). Concentration of the analyte in plants was calculated as described in Section 5.2.4.7.

5.3 TOXICITY ASSESSMENT

Toxicity information for the COPCs was obtained from U.S. EPA toxicity databases, including the 1994 fourth quarter edition of Integrated Risk Information System (IRIS) (U.S. EPA 1994d) and the 1994 Annual Health Effects Assessment Summary Tables (HEAST) (U.S. EPA 1994c).

5.3.1 Toxicity Values for Non-carcinogenic Chemicals

Non-carcinogenic toxicity values for COPCs are shown in Table 5-5. This table provides the critical effect, reference dose (RfD) for both oral and inhalation exposure routes (if available), and the source for these RfDs. The confidence level, uncertainty factor (UF), and modifying factor (MF) assigned to each toxicity value by the U.S. EPA is also provided. The confidence level is a measure of the uncertainty associated with the experiments upon which the RfD is based. Uncertainty factors reflect the uncertainties associated within the data extrapolations for estimating the RfD (e.g., subchronic versus chronic study; rodent or primate versus human study). The modifying factor, which ranges from 1-10, is also based on an evaluation of the uncertainties of the data used to create an RfD. U.S. EPA uses a default modifying factor of one.

5.3.2 Toxicity Values for Carcinogenic Chemicals

Carcinogenic toxicity values for COPCs are shown in Table 5-6. This table provides the cancer slope factor (SF) for both oral and inhalation exposure pathways (if available). There are currently no SFs available for dermal exposure. The uncertainty associated with the carcinogenic potential of these

TABLE 5-5. ORAL/INHALATION CHRONIC NON-CARCINOGENIC TOXICITY VALUES FOR KOTZEBUE LRRS
(Page 1 of 4)

Oral												Inhalation					
Chemical	RfD (mg/kg/day)	Confidence	MF	UF	Critical Effect	Source	RfC (mg/m ³)	Confidence	MF	UF	Critical Effect	Source					
1,2,4 Trichlorobenzene	1E-2	Medium	1	1000	Increased adrenal weights	IRIS	Pending	-	-	-	-	IRIS					
1,1,2 Trichloroethane	4E-3	Medium	1	1000	Liver effects, depressed humoral immune response	IRIS	-	-	-	-	-	-					
1,4 Dichlorobenzene	-	-	-	-	-	-	2.29E-1	Medium	1	100	Increased liver weight/nephropathy	IRIS					
1,1 Dichloroethene	9E-3	Medium	1	1000	Hepatic lesions	IRIS	-	-	-	-	-	-					
2,4 Dichlorophenol	3E-3	Low	1	100	Immune system; decreased delayed hypersensitivity response	IRIS	-	-	-	-	-	-					
1,2 Dichloropropane	-	-	-	-	-	-	4E-3	Medium	1	300	Hyperplasia of the nasal mucosa	HEAST					
1,3 Dichloropropene	3E-4	Low	1	10,000	Increased organ weights	IRIS	2E-2	High	1	30	Hypertrophy of the nasal epithelium	IRIS					
2,4 Dinitrotoluene	2E-3	High	1	100	Neurotoxicity	IRIS	-	-	-	-	-	-					
2,6 Dinitrotoluene	1E-3	-	1	3000	Mortality/neurotoxicity	HEAST	-	-	-	-	-	-					
4-Chloroaniline	4E-3	Low	1	3000	Non-neoplastic lesions of the splenic capsule	IRIS	-	-	-	-	-	-					
4,4-DDT	5E-4	Medium	1	100	Liver lesions	IRIS	-	-	-	-	-	-					
2-Nitroaniline	6E-5	-	-	-	-	W/D	5.71E-5	-	-	-	Hematological effects	HEAST					
3-Nitroaniline	3E-3	-	-	-	-	EPA Region III	-	-	-	-	-	-					
4-Nitroaniline	3E-3	-	-	-	-	EPA Region III	-	-	-	-	-	-					
Acenaphthylene	Pending	-	-	-	-	IRIS	-	-	-	-	-	-					
Aldrin	3E-5	Medium	1	1000	Liver toxicity	IRIS	-	-	-	-	-	-					
Antimony	4E-4	Low	1	1000	Longevity, blood glucose and cholesterol	IRIS	-	-	-	-	-	-					
Arsenic	3E-4	Medium	1	3	Hyperpigmentation, Keratosis	IRIS	-	-	-	-	-	-					
Aroclor 1016	7E-5	-	1	100	Reduced birth weight, prenatally exposed neurobehavioral deficits	IRIS	-	-	-	-	-	-					

TABLE 5-5. ORAL/INHALATION CHRONIC NON-CARCINOGENIC TOXICITY VALUES FOR KOTZEBUE LRRS
(Page 2 of 4)

Oral												Inhalation				
Chemical	RfD (mg/kg/day)	Confidence	MF	UF	Critical Effect	Source	RfC (mg/m ³)	Confidence	MF	UF	Critical Effect	Source				
Aroclor 1221	7E-5 ^b	-	1	100	-	IRIS	-	-	-	-	-	-				
Aroclor 1232	7E-5 ^b	-	1	100	-	IRIS	-	-	-	-	-	-				
Aroclor 1242	7E-5 ^b	-	1	100	-	IRIS	-	-	-	-	-	-				
Aroclor 1248	7E-5 ^b	-	1	100	-	IRIS	-	-	-	-	-	-				
Aroclor 1254	2E-5	Medium	1	100	Ocular exudate, inflamed & prominent eyelid meibomian glands, distorted fingernails & toenail growth & decreased antibody response	IRIS	-	-	-	-	-	-				
Aroclor 1260	7E-5 ^b	-	1	100	-	IRIS	-	-	-	-	-	-				
Beryllium	5E-3	Low	1	100	No adverse effects	IRIS	-	-	-	-	-	-				
Bis(2-ethylhexyl)phthalate	2E-2	Medium	1	1000	Increased relative liver weight	IRIS	-	-	-	-	-	-				
Bromodichloromethane	2E-2	Medium	1	1000	Renal cytomegaly	IRIS	-	-	-	-	-	-				
Bromoform	2E-2	Medium	1	1000	Hepatic lesions	IRIS	-	-	-	-	-	-				
Bromomethane	1.4E-3	Medium	1	1000	Epithelial hyperplasia of the forestomach	IRIS	5E-3	High	1	100	Lesions in the nasal cavity	IRIS				
Cadmium	1E-4	High	1	10	Proteinuria	IRIS	-	-	-	-	-	-				
Carbon disulfide	1E-1 ^a	Medium	1	100	Fetal toxicity/malformations	IRIS	2.8E-3	Pending review	-	-	-	IRIS				
Carbon tetrachloride	7E-4	Medium	1	1000	Liver lesions	IRIS	-	-	-	-	-	-				
Chlorobenzene	2E-2	Medium	1	1000	Histopathological changes in the liver	IRIS	5.7E-3	Pending review	-	-	-	IRIS				
Chlordane, alpha	6E-5	Medium	1	1000	Liver hypertrophy	IRIS	-	-	-	-	-	-				
Chlordane, beta	6E-5	Medium	1	1000	Liver hypertrophy	IRIS	-	-	-	-	-	-				
Chloroform	1E-2	Medium	1	1000	Liver lesions	IRIS	-	-	-	-	-	-				
Dibenzofuran	4E-3	-	-	-	-	EPA Region III	-	-	-	-	-	-				
Dibromochloromethane	2E-2	Medium	1	1000	Hepatic lesions	IRIS	-	-	-	-	-	-				

TABLE 5-5. ORAL/INHALATION CHRONIC NON-CARCINOGENIC TOXICITY VALUES FOR KOTZEBUE LRRS
(Page 3 of 4)

Oral												Inhalation				
Chemical	RfD (mg/kg/day)	Confidence	MF	UF	Critical Effect	Source	RfC (mg/m³)	Confidence	MF	UF	Critical Effect	Source				
Dieldrin	5E-5	Medium	1	100	Liver lesions	IRIS	-	-	-	-	-	-				
Endrin	3E-4	Medium	1	100	Mild histological lesions in the liver, occasional convulsions	IRIS	-	-	-	-	-	-				
Heptachlor	5E-4	Low	1	300	Increased liver weight (males)	IRIS	-	-	-	-	-	-				
Heptachlor Epoxide	1.3E-5	Low	1	1000	Increased liver to body weight ratio	IRIS	-	-	-	-	-	-				
Hexachlorobenzene	8E-4	Medium	1	100	Liver effects	IRIS	-	-	-	-	-	-				
Hexachlorocyclopentadiene	7E-3	Low	1	1000	Stomach lesions	IRIS	-	-	-	-	-	-				
Hexachloroethane	1E-3	Medium	1	1000	Atrophy and degeneration of the renal tubules	IRIS	-	-	-	-	-	-				
Isophorone	2E-1	Medium	1	1000	No observed effects	IRIS	-	-	-	-	-	-				
Lead	N/A	N/A	-	-	Hematological changes, brain & kidney damage, CNS effects	IRIS	-	-	-	-	-	-				
Xylenes, total	2E+0	Medium	1	100	CNS effects & decreased weight	IRIS	-	-	-	-	-	-				
Manganese (food)	1.4E-1	N/A	1	1	CNS effects	IRIS	-	-	-	-	-	-				
Manganese (water)	5E-3	N/A	1	1	CNS effects	IRIS	-	-	-	-	-	-				
Manganese (food & water)	-	-	-	-	-	-	5E-5	Medium	1	1000	Impaired neurobehavioral functioning	IRIS				
Methylene chloride	6E-2	High	1	100	Liver toxicity	IRIS	-	-	-	-	-	-				
Nitrobenzene	5E-4	Medium	1	10,000	Hematologic; adrenal renal and hepatic lesions	IRIS	2E-3	-	-	10,000	Adrenal, kidney & liver lesions	HEAST				
Naphthalene	4E-2	-	-	-	-	W/D from IRIS	-	-	-	-	-	-				
Pentachlorophenol	3E-2	High	1	100	Liver & kidney pathology	IRIS	-	-	-	-	-	-				
Selenium	5E-3	High	1	3	Clinical selenosis	IRIS	-	-	-	-	-	-				
Styrene	2E-1	Medium	1	1000	Red blood cell and liver effects	IRIS	1E+0	Medium	1	30	CNS effects	IRIS				
Tetrachloroethylene	1E-2	Medium	1	1000	Hepatotoxicity, weight gain	IRIS	-	-	-	-	-	-				

TABLE 5-5. ORAL/INHALATION CHRONIC NON-CARCINOGENIC TOXICITY VALUES FOR KOTZEBUE LRRS
(Page 4 of 4)

Oral													Inhalation					
Chemical	RfD (mg/kg/day)	Confidence	MF	UF	Critical Effect	Source	RfC (mg/m ³)	Confidence	MF	UF	Critical Effect	Source						
Trichloroethylene	6E-3	-	-	-	-	EPA Region III	-	-	-	-	-	-						

^a A route to route extrapolation was performed.

^b Based upon RfD for Aroclor 1016.

N/A = Not Applicable.

The following principle sources of toxicity values were used:

Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profiles - Chemical Specific.

U.S. Environmental Protection Agency (EPA), 1994, Integrated Risk Information System (IRIS), Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA), 1994, Health Effects Assessment Summary Tables (HEAST), Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA) Region III, Risk Based Concentration Table, Fourth Quarter 1994.

TABLE 5-6. ORAL/INHALATION CARCINOGENIC TOXICITY VALUES FOR KOTZEBUE LRRS
(Page 1 of 3)

Chemical	Slope Factor (mg/kg/Day) ⁻¹		Weight of Evidence	Tumor			Source
	Oral	Inhalation		Oral	Inhalation		
1,1,1,2,2 Tetrachloroethane	2E-1	5.8E-5 ^b	C	Hepatocellular carcinomas	-	IRIS	
2,4,6 Trichlorophenol	1.1E-2	-	B2	Lymphoma, leukemia, hepatocellular carcinomas	-	IRIS	
1,1,1,2 Trichloroethane	5.7E-2	1.6E-5 ^b	C	Hepatocellular carcinomas	-	IRIS	
1,4 Dichlorobenzene	2.4E-2	-	B2	Liver	-	HEAST	
3,3' Dichlorobenzidine	4.5E-1	-	B2	Mammary gland, possible liver	-	IRIS	
1,2 Dichloroethane	9.1E-2	2.6E-5 ^b	B2	Lung papillomas, hemanigosarcomas	-	IRIS	
1,1 Dichloroethene	6.0E-1	5.0E-5	C	Adrenal pheochromocytomas	Kideny adenocarcinoma	IRIS	
1,2 Dichloropropane	6.8E-2	-	B2	Liver	-	IRIS	
1,3 Dichloropropene	1.75E-1	-	B2	Forestomach, thyroid, adrenal	-	HEAST	
2,4 Dinitrololuene/2,6 Dinitrololuene	6.8E-1 ^e	-	B2	Liver, mammary gland	-	IRIS	
4,4'-DDD	2.4E-1	-	B2	Lung, liver, thyroid	-	IRIS	
4,4'-DDE	3.4E-1	-	B2	Liver, thyroid	-	IRIS	
4,4'-DDT	3.4E-1	3.4E-1 ^b	B2	Liver	-	IRIS	
Aldrin	1.7E+1	1.7E+1 ^b	B2	Liver carcinomas	-	IRIS	
Arsenic	1.75E+0	1.51E+1	A	Skin cancer	Lung	IRIS	
Aroclor 1016	7.7E+0 ^c	-	B2	Hepatocellular carcinomas	-	IRIS	
Aroclor 1221	7.7E+0 ^c	-	B2	Hepatocellular carcinomas	-	IRIS	
Aroclor 1232	7.7E+0 ^c	-	B2	Hepatocellular carcinomas	-	IRIS	
Aroclor 1242	7.7E+0 ^c	-	B2	Hepatocellular carcinomas	-	IRIS	
Aroclor 1248	7.7E+0 ^c	-	B2	Hepatocellular carcinomas	-	IRIS	
Aroclor 1254	7.7E+0 ^c	-	B2	Hepatocellular carcinomas	-	IRIS	
Aroclor 1260	7.7E+0 ^c	-	B2	Hepatocellular carcinomas	-	IRIS	
Benzene	2.9E-2 ^a	2.9E-2	A	Nonlymphocytic leukemia	Nonlymphocytic leukemia	IRIS	
Benzo[a]anthracene	7.3E-1 ^d	-	B2	Pulmonary adenoma & hepatoma	-	IRIS	

TABLE 5-6. ORAL/INHALATION CARCINOGENIC TOXICITY VALUES FOR KOTZEBUE LRRS
(Page 2 of 3)

Chemical	Slope Factor (mg/kg/Day) ⁻¹		Weight of Evidence	Tumor		Source
	Oral	Inhalation		Oral	Inhalation	
Benzo[a]pyrene	7.3E+0	-	B2	Forestomach tumors, squamous cell papillomas & carcinomas	-	IRIS
Benzo[b]fluoranthene	7.3E-1 ^d	-	B2	Epidermal carcinomas & pleomorphic sarcomas	-	IRIS
Benzo[k]fluoranthene	7.3E-2 ^d	-	B2	Lung papillomas and carcinomas	-	IRIS
Beryllium	4.3E+0	8.4E+0	B2	Gross tumors, all sites	Lung	IRIS
BHC, alpha	6.3E+0	-	B2	Hepatocellular carcinomas	-	IRIS
BHC, beta	1.8E+0	-	C	Hepatocellular carcinomas	-	IRIS
Bis(2-ethylhexyl)phthalate	1.4E-2	-	B2	Hepatocellular carcinomas/adenoma	-	IRIS
Bromodichloromethane	6.2E-2	-	B2	Kidney	-	IRIS
Bromoform	7.9E-3	3.9E-3 ^b	B2	Neoplastic lesions of the large intestine	-	IRIS
Carbon tetrachloride	1.3E-1	5.3E-2 ^b	B2	Hepatocellular carcinomas, hematomas	-	IRIS
Chlordane, alpha	1.3E+0	1.29E+0 ^b	B2	Hepatocellular carcinomas	-	IRIS
Chlordane, gamma	1.3E+0	1.29E+0 ^b	B2	Hepatocellular carcinomas	-	IRIS
Chloroform	6.1E-3	8.1E-2 ^b	B2	Kidney epithelial tumors, hepatic carcinomas	-	IRIS
Chloromethane	1.3E-2	6.3E-3 ^b	C	Kidney	-	IRIS
Chrysene	7.3E-3 ^d	-	B2	Carcinomas, malignant lymphomas	-	IRIS
Dibenzo[a,h]anthracene	7.3E+0 ^d	-	B2	Pulmonary carcinomas	-	IRIS
Dibromochloromethane	8.4E-2	-	C	Hepatocellular carcinomas and adenomas	-	IRIS
Dieldrin	1.6E+1	1.6E+1 ^b	B2	Liver carcinomas	-	IRIS
Heptachlor	4.5E+0	1.3E-3 ^b	B2	Hepatocellular carcinomas	-	IRIS
Heptachlor epoxide	9.1E+0	9.1E+0	B2	Hepatocellular carcinomas	-	IRIS
Hexachlorobenzene	1.6E+0	-	B2	Liver, thyroid, kidney	-	IRIS
Hexachlorobutadiene	7.8E-2	-	C	Renal tubular adenomas	-	IRIS
Hexachloroethane	1.4E-2	-	C	Hepatocellular carcinomas	-	IRIS
Indeno(1,2,3-cd)pyrene	7.3E-1 ^a	-	B2	Lung (epidermoid) carcinomas	-	IRIS

TABLE 5-6. ORAL/INHALATION CARCINOGENIC TOXICITY VALUES FOR KOTZEBUE LRRS
(Page 3 of 3)

Chemical	Slope Factor (mg/kg/Day) ⁻¹		Weight of Evidence	Tumor		Source
	Oral	Inhalation		Oral	Inhalation	
Isophorone	9.5E-4	-	C	Preputial gland carcinoma	-	IRIS
Lead	N/A	N/A	B2	Renal	-	IRIS
Methylene chloride	7.5E-3	1.64E-3	B2	Hepatocellular carcinomas & adenomas, hepatocellular cancer	Combined carcinomas & adenomas	IRIS
N-Nitrosodi-n-propylamine	7.0E+0	-	-	Hepatocellular carcinomas	-	IRIS
N-Nitrosodiphenylamine	4.9E-3	-	C	Bladder	-	IRIS
Pentachlorophenol	1.2E-1	-	B2	Hepatocellular adenomas & carcinomas	-	IRIS
Tetrachloroethylene	Under review	-	-	-	-	IRIS
Toxaphene	1.1E+0	1.1E+0 ^b	B2	Hepatocellular carcinomas, neoplastic nodules (adenomas)	-	IRIS
Vinyl chloride	1.9E+0	3.0E-1	A	Lung and liver	Liver	HEAST

^a Based on route to route extrapolation from inhalation.

^b Based on route to route extrapolation from oral ingestion.

^c Based upon SF for PCBs.

^d SF derived from Benzo(a)pyrene using a relative potency of:

Benzo(a)anthracene = 0.1
 Benzo(b)fluoranthene = 0.1
 Benzo(k)fluoranthene = 0.01
 Dibenzo(a,h)anthracene = 1.0
 Chrysene = 0.001
 Indeno(1,2,3-cd)pyrene = 0.1

^e Carcinogenic effects only noted for the mixture of 2,4 Dinotroterluene and 2,6 Dinotoleluene.

The following principle sources of toxicity values were used:

U.S. Environmental Protection Agency (EPA), 1994. Integrated Risk Information System (IRIS), Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA) 1994. Health Effects Assessment Summary Tables (HEAST), Office of Solid Waste and Emergency Response, Washington, D.C.

chemicals is expressed by U.S. EPA's weight of evidence classification. Each chemicals falls into one of five classes depending upon the evaluation of human and animal studies. The classifications include:

Group	Category
A	Human Carcinogen
B	Probable human carcinogen B1 - Limited human evidence B2 - Sufficient evidence in animals, no human evidence
C	Possible human carcinogen
D	Not classifiable as a human carcinogen
E	Evidence of noncarcinogenicity in humans

5.3.3 Toxicity Values for Dermal Exposure

There are currently no U.S. EPA reference doses or slope factors for dermal exposure. According to U.S. EPA guidelines, oral RfDs and SFs can be adjusted by using chemical specific oral absorption efficiency factors to characterize the risk from dermal exposure (U.S. EPA 1989a). This adjustment accounts for the difference between an orally administered dose and a dermally absorbed dose. Oral absorption efficiencies were obtained from chemical specific ATSDR toxicological profiles. The calculations were as follows:

$$\begin{array}{llll} \text{Adjustment for RfD:} & \text{RfD} \times \text{oral absorption efficiency (\%)} & = & \text{Dermally adjusted RfD} \\ \text{Adjustment for SF:} & \text{SF} / \text{oral absorption efficiency (\%)} & = & \text{Dermally adjusted SF} \end{array}$$

Chemicals which readily volatilize, including all volatile organics and semi-volatile organic compounds with a vapor pressure greater than $2.4\text{E-}7 \text{ atm}\cdot\text{L}\cdot\text{mole}^{-1}$, were assumed not to pose a substantial risk upon dermal exposure (Wang and Jones 1994). Oral absorption efficiencies for detected semi-volatile organic compounds with a vapor pressure less than $2.4\text{E-}7 \text{ atm}\cdot\text{L}\cdot\text{mole}^{-1}$, pesticides, and PCBs are shown in Table 5-7, along with the appropriate ATSDR toxicological profile source.

TABLE 5-7. ORAL ABSORPTION EFFICIENCY FACTORS FOR KOTZEBUE LRRS (Page 1 of 2)

CHEMICAL	ORAL ABSORPTION EFFICIENCIES	REFERENCE
Acenaphthene	0.85	ATSDR 1993
Anthracene	0.85	ATSDR 1993
Aldrin	0.5	ATSDR 1991
Aroclor 1016	0.90	Adopted from Aroclor 1260
Aroclor 1221	0.90	Adopted from Aroclor 1260
Aroclor 1232	0.90	Adopted from Aroclor 1260
Aroclor 1242	0.90	Adopted from Aroclor 1260
Aroclor 1248	0.90	Adopted from Aroclor 1260
Aroclor 1254	0.90	Adopted from Aroclor 1260
Aroclor 1260	0.90	ATSDR 1993
Benzo(a)pyrene	0.8	ATSDR 1993
Benzo(a)anthracene	0.85	ATSDR 1993
Benzo(b)fluoranthene	0.85	ATSDR 1993
BHC, alpha	0.97	ATSDR 1989
BHC, beta	0.91	ATSDR 1989
BHC, gamma	0.99	ATSDR 1989
bis(2-ethylhexyl)phthalate	0.55	ATSDR 1991
Butyl benzyl phthalate	1.0	ATSDR 1989
Chlordane	0.80	ATSDR 1989
Chrysene	0.87	ATSDR 1993
DDD	0.90	ATSDR 1988
DDE	0.90	ATSDR 1988
DDT	0.90	ATSDR 1989
di-n-butyl phthalate	1.00	ATSDR 1989
Dichlorobenzidine, 3,3'-	0.90	ATSDR 1989
Dichloroethane, 1,2-	1.0	EPA 1984
Dichloroethene, 1,1-	1.0	ATSDR 1989

TABLE 5-7. ORAL ABSORPTION EFFICIENCY FACTORS FOR KOTZEBUE LRRS (Page 2 of 2)

CHEMICAL	ORAL ABSORPTION EFFICIENCIES	REFERENCE
Dichloropropane, 1,2-	0.90	EPA 1984
Dieldrin	0.50	ATSDR 1991
Diethyl phthalate	1.0	ATSDR 1989
Dinitrotoluene, 2,4-	0.90	ATSDR 1989
Dinitrotoluene, 2,6-	0.90	ATSDR 1989
Endosulfan	0.88	ATSDR 1988
Fluoranthene	0.85	ATSDR 1993
Heptachlor epoxide	0.66	ATSDR 1991
Isophorone	0.93	ATSDR 1988
Methylene chloride	0.78	ATSDR 1992
N-nitrosodi-n-propylamine	0.78	ATSDR 1989
N-nitrosodiphenylamine	0.98	ATSDR 1989
Phenol	0.95	ATSDR 1988
Pyrene	0.92	ATSDR 1993
Tetrachloroethylene	0.90	ATSDR 1992
Trichloroethane, 1,1,2	1.0	ATSDR 1989
Trichloroethylene	0.98	ATSDR 1991
Vinyl chloride	0.03	ATSDR 1992

5.3.4 Toxicity Profiles

A short toxicological profile for each detected COPC at the Kotzebue LRRS is included in Appendix E. General toxicity information and a summary of the information used in the development of the slope factor or reference dose is provided for each COPC. Sources for the toxicological information are (in order of hierarchy): IRIS (U.S. EPA 1994d); HEAST (U.S. EPA 1994c); and ATSDR toxicological profiles (chemical specific).

5.4 RISK CHARACTERIZATION

Carcinogenic and non-carcinogenic risks were evaluated separately due to the differences in toxicological data. Carcinogenic risk probabilities were assumed to be proportional to dose, while non-carcinogenic risk ratios were developed by comparing potential intake levels with the critical dose for each chemical of potential concern. Risks were determined for individual chemical parameters, as well as for additive effects. The total risk for each pathway was determined by summing the individual risks from each COPC. Detected and non-detected COPCs were evaluated separately.

This section presents the risk estimates for each of the pathways evaluated at Kotzebue LRRS (see Section 5.4.3). A summary section of the risk estimates (Section 5.4.4) includes the total risk from all pathways for each investigative area and a description in tabular and graphical form of the locations at which samples with COPC concentrations of potential concern were collected.

5.4.1 Carcinogenic Risks

Carcinogenic risk probabilities were calculated by multiplying the exposure intake (EI) by the route-specific cancer slope factor (SF):

$$R_c = EI \times SF_c \quad (\text{Equation 5-16})$$

where:

R_c	=	Estimated individual excess lifetime cancer risk for chemical c
SF_c	=	Route and chemical-specific cancer slope factor for chemical c (kg•day/mg)
EI	=	Exposure intake [mg/(kg•day)]

An excess individual lifetime cancer risk of $1.0\text{E-}6$ (10^{-6}) is generally used by the U.S. EPA as a benchmark when determining whether chemical exposures represent a potentially unacceptable level of risk to public health. According to the revised National Contingency Plan (NCP) (U.S. EPA 1990b), carcinogenic risks from exposure at Superfund sites are considered to be unacceptable at a level greater than $1.0\text{E-}4$ (10^{-4}), while risks smaller than $1.0\text{E-}6$ are considered to be of minimal concern. For the purposes of this risk assessment, an excess individual lifetime cancer risk of $1.0\text{E-}6$ was used to assess the potential for adverse impact to public health from the contamination at Kotzebue LRRS.

5.4.2 Noncarcinogenic Health Effects

Non-carcinogens are considered to exhibit threshold effects (i.e., a critical chemical dose must be exceeded before a health effect is observed). The potential for adverse health effects is assessed by the ratio of the exposure intake (EI) and the route-specific reference dose (RfD).

$$HQ_c = EI / RfD_c \quad (\text{Equation 5-17})$$

where:

HQ_c	=	Hazard quotient for chemical c
RfD_c	=	Route-specific reference dose for chemical c (kg•day/mg)
EI	=	Exposure intake [mg/(kg•day)]

The hazard quotient (HQ) is accepted by the U.S. EPA as a way to quantify levels of risk for non-carcinogens (U.S. EPA 1989a). A HQ value greater than one indicates that adverse health effects may occur due to chemical exposure.

5.4.3 Risk Estimates

The following sections characterize the risk associated with chemical contaminants detected at Kotzebue LRRS. Appendix F presents the HQ and/or carcinogenic risk estimates for each COPC.

As discussed in Section 4.2, the Kotzebue LRRS was divided into four areas based on considerations of surface water drainage patterns, historical spill locations, consideration of human exposure pathways, and

potential remediation efforts (see Figure 4-1). The resulting four areas (see Figures 4-2, 4-3, 4-4, and 4-5) are listed below:

- White Alice
- Beach Site
- West Drainage
- East Drainage.

Risks estimates were characterized at each of these four areas by calculating EPCs for all COPCs (see Section 5.1) and using the equations and assumed parameters discussed in Section 5.2. Separate risk estimates for all four areas listed above were only calculated for soil ingestion and dermal contact exposure pathways. Risk estimates for other exposure pathways (i.e., ingestion of water, dermal contact with water, and ingestion of berries), were evaluated for only a portion of these areas, or were evaluated only by considering all data collected at the Kotzebue LRRS (i.e., inhalation and ingestion of marine or terrestrial organisms).

5.4.3.1 Inhalation Of Airborne Dust. The risk estimates from detected COPCs for inhalation of carcinogenic chemicals in dust were $2.18\text{E-}6$ and $2.04\text{E-}6$ for adults and children, respectively (Table 5-8). The carcinogenic risk from non-detected COPCs was approximately 10 percent of the risk from the detected COPCs. There was no non-carcinogenic risk from either detected or non-detected COPCs for either adults or children (Table 5-8). The total carcinogenic risk via this pathway of $2.14\text{E-}6$ for adults and $2.00\text{E-}6$ for children exceeds the $1.0\text{E-}6$ risk threshold of concern due entirely to arsenic (Table 5-9).

5.4.3.2 Inhalation Of Volatile Chemicals. The risk estimates from detected COPCs for inhalation of volatile carcinogenic chemicals were $5.53\text{E-}8$ and $5.18\text{E-}8$ for adults and children, respectively (Table 5-8). The carcinogenic risk from non-detected COPCs was approximately 5 times higher than the risk from the detected COPCs. Non-carcinogenic risk from detected COPCs from this pathway was zero, but was 7.34 and 20.64 for adults and children, respectively, from non-detected COPCs. The HQ values in exceedance of 1 were due primarily to the high PQL for nitrobenzene.

5.4.3.3 Ingestion of Soil/Sediment. The risk estimates to adults for ingestion of carcinogenic chemicals in soil at Kotzebue LRRS ranged from $1.62\text{E-}6$ at the Beach area to $4.45\text{E-}6$ at the White Alice area

TABLE 5-8. ESTIMATED RISK DUE TO INHALATION

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
Inhalation Due to Volatilization	5.53E-8	0.00	5.18E-8	0.00
Inhalation Due to Dust	2.18E-6	0.00	2.04E-6	0.00
NON-DETECTED COPCs				
Inhalation Due to Volatilization	--	7.34	--	20.64
Inhalation Due to Dust	2.49E-7	0.00	2.33E-7	0.00

TABLE 5-9. ESTIMATED RISK FROM INHALATION OF DUST

Location	Receptor	Chemical	Risk Type	Soil Concentration (mg/kg)	Calculated Air Concentration (mg/m ³)	Intake Factor (mg/kg/day) ⁻¹	Oral SF (mg/kg/day) ⁻¹	Cancer Risk (Dose x SF)
ADULT RISKS								
Entire Site	Adult	Arsenic	Carcinogenic	9.86	1.18E-5	1.2E-2	1.51E+1	2.14E-6
CHILD RISKS								
Entire Site	Child	Arsenic	Carcinogenic	9.86	1.18E-5	1.13E-2	1.51E+1	2.00E-6

(Table 5-10). The carcinogenic risk estimates to children from this pathway ranged from $5.02\text{E-}6$ at the Beach area to $1.38\text{E-}5$ at the White Alice area (Table 5-10). The HQ estimates for ingestion of non-carcinogenic chemicals in soil were 0.03 or less for adults and ranged from 0.12 at the Beach area to 0.30 at the White Alice area for children (Table 5-10). Risk estimates for non-detected COPCs were approximately 2-3 times higher than risk estimates for detected COPCs (Table 5-10).

Carcinogenic chemicals detected in soil that pose an estimated risk greater than $1.0\text{E-}6$ to adults or children from soil ingestion include arsenic at all four areas and Arochlor 1260 at the White Alice area (Table 5-11).

The risk estimates to adults for ingestion of carcinogenic chemicals in sediment at Kotzebue LRRS ranged from $7.02\text{E-}9$ at the West Drainage area to $1.38\text{E-}6$ at the White Alice area (Table 5-10). The carcinogenic risk estimates to children from this pathway ranged from $2.19\text{E-}8$ at the West Drainage area to $4.31\text{E-}6$ at the White Alice area (Table 5-10). The HQ estimates for ingestion of non-carcinogenic chemicals in soil were less than 0.10 for all areas for both adults and children (Table 5-10). Risk estimates for non-detected COPCs were up to 65 times higher than risk estimates for detected COPCs (Table 5-10).

The exceedance of the $1.0\text{E-}6$ cancer risk threshold at the White Alice area was due to arsenic. Arochlor 1221 was primarily responsible for the higher cancer risk estimates among the non-detected COPCs.

5.4.3.4 Dermal Contact With Soil/Sediments. The risk estimates to adults for dermal contact with carcinogenic chemicals in soil at Kotzebue LRRS ranged from $2.04\text{E-}7$ at the East Drainage area to $1.76\text{E-}5$ at the White Alice area (Table 5-12). The carcinogenic risk estimates to children from this pathway ranged from $1.26\text{E-}7$ at the East Drainage area to $1.08\text{E-}5$ at the White Alice area (Table 5-12). The highest HQ estimates for dermal contact with non-carcinogenic chemicals in soil were 0.12 and 0.22 for adults and children, respectively, in the White Alice area (Table 5-12). Risk estimates for non-detected COPCs were generally less than 1 percent of the risk estimates for detected COPCs (Table 5-12).

The risk estimates to adults for dermal contact with carcinogenic chemicals in sediment at Kotzebue LRRS ranged from $2.10\text{E-}8$ at the West Drainage area to $1.96\text{E-}6$ at the White Alice area (Table 5-12). The carcinogenic risk estimates to children from this pathway ranged from $1.29\text{E-}8$ at the West Drainage area to $1.20\text{E-}6$ at the White Alice area (Table 5-12). The hazard quotient estimates for ingestion of non-

TABLE 5-10. ESTIMATED RISK FROM INGESTION OF SOIL/SEDIMENT

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
<i>Ingestion of Soil</i>				
Beach Area	1.62E-6	0.01	5.02E-6	0.12
East Drainage	2.15E-6	0.03	6.70E-6	0.23
White Alice Area	4.45E-6	0.03	1.38E-5	0.30
West Drainage	2.25E-6	0.02	7.00E-6	0.18
<i>Ingestion of Sediment</i>				
East Drainage	3.25E-7	0.01	2.53E-7	0.01
White Alice Area	1.38E-6	0.01	4.31E-6	0.09
West Drainage	7.02E-9	0.01	2.19E-8	0.01
NON-DETECTED COPCs				
<i>Ingestion of Soil</i>				
Beach Area	4.00E-6	0.01	1.24E-5	0.11
East Drainage	4.22E-6	0.03	1.31E-5	0.31
White Alice Area	1.20E-5	0.06	3.74E-5	0.56
West Drainage	6.61E-6	0.03	2.06E-5	0.31
<i>Ingestion of Sediment</i>				
East Drainage	1.25E-6	0.02	3.90E-6	0.20
White Alice Area	8.62E-7	0.01	2.68E-6	0.07
West Drainage	4.62E-7	0.01	1.44E-6	0.01

TABLE 5-11. ESTIMATED RISK FROM SOIL/SEDIMENT INGESTION

Location	Receptor	Chemical	Risk Type	Soil Concentration (mg/kg)	Intake Factor (mg/kg/day)	Oral SF (mg/kg/day) ⁻¹	Cancer Risk (Dose x SF)
ADULT RISKS							
Soil							
Beach Area	Adult	Arsenic	Carcinogenic	7.00	1.21E-7	1.75	1.48E-6
East Drainage	Adult	Arsenic	Carcinogenic	9.41	1.21E-7	1.75	1.99E-6
West Drainage	Adult	Arsenic	Carcinogenic	7.84	1.21E-7	1.75	1.66E-6
White Alice	Adult	Arsenic	Carcinogenic	10.0	1.21E-7	1.75	2.11E-6
White Alice	Adult	Arochlor 1260	Carcinogenic	2.10	1.21E-7	7.7	1.95E-6
Sediment							
White Alice	Adult	Arsenic	Carcinogenic	5.00	1.21E-7	1.75	1.06E-6
CHILD RISKS							
Soil							
Beach Area	Child	Arsenic	Carcinogenic	7.00	3.76E-7	1.75	4.60E-6
East Drainage	Child	Arsenic	Carcinogenic	9.41	3.76E-7	1.75	6.19E-6
West Drainage	Child	Arsenic	Carcinogenic	7.84	3.76E-7	1.75	5.15E-6
West Drainage	Child	Arochlor 1260	Carcinogenic	0.041	3.76E-7	7.7	1.18E-6
White Alice	Child	Arsenic	Carcinogenic	10.0	3.76E-7	1.75	6.58E-6
White Alice	Child	Arochlor 1260	Carcinogenic	2.10	3.76E-7	7.7	6.07E-6
Sediment							
White Alice	Child	Arsenic	Carcinogenic	5.00	3.76E-7	1.75	3.29E-6

TABLE 5-12. ESTIMATED RISK FROM DERMAL CONTACT WITH SOIL/SEDIMENT

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
<i>Dermal Contact with Soil</i>				
Beach Area	2.32E-7	0.01	1.43E-7	0.01
White Alice Area	1.76E-5	0.12	1.08E-5	0.22
East Drainage	2.04E-7	0.01	1.26E-7	0.01
West Drainage	3.68E-6	0.03	2.27E-6	0.06
<i>Dermal Contact with Sediment</i>				
East Drainage	4.86E-7	0.01	2.99E-7	0.01
White Alice Area	1.96E-6	0.01	1.20E-6	0.02
West Drainage	2.10E-8	0.01	1.29E-8	0.01
NON-DETECTED COPCs				
<i>Dermal Contact with Soil</i>				
Beach Area	3.79E-9	0.01	2.34E-9	0.01
White Alice Area	4.16E-8	0.01	2.56E-8	0.01
East Drainage	6.26E-9	0.01	3.85E-9	0.01
West Drainage	1.54E-8	0.01	9.50E-9	0.01
<i>Dermal Contact with Sediment</i>				
East Drainage	2.02E-6	0.01	1.24E-6	0.01
White Alice Area	2.91E-6	0.01	1.79E-6	0.01
West Drainage	1.48E-6	0.01	9.11E-7	0.01

carcinogenic chemicals in soil were 0.02 or less for both adults and children (Table 5-12). Risk estimates for non-detected COPCs were up to 70 times higher than risk estimates for detected COPCs (Table 5-12).

The exceedance of the $1.0\text{E-}6$ cancer risk threshold at the White Alice (soil and sediment) and West Drainage (soil only) areas was due to Aroclor 1260 (Table 5-13). Among non-detected COPCs, only benzo(a)pyrene exceeded a $1.0\text{E-}6$ cancer risk.

5.4.3.5 Dermal Contact with Surface Water. The risk estimates for dermal contact with carcinogenic chemicals detected in the surface water exceeded $1.0\text{E-}6$ for the White Alice, East Drainage, and West Drainage areas. The total carcinogenic risk to adults ranged from $7.45\text{E-}6$ at the White Alice area to $5.51\text{E-}5$ at the West Drainage area. The total carcinogenic risk to children ranged from $1.15\text{E-}6$ at the White Alice area to $3.38\text{E-}5$ at the West Drainage area (Table 5-14). The HQ estimates for non-carcinogenic chemicals were greater than 1.0 for adults at the West Drainage area (1.78) and for children at both the East Drainage area (1.60) and the West Drainage area (3.31). The total risk from non-detected COPCs was several orders of magnitude higher than for detected COPCs, particularly for carcinogenic chemicals (Table 5-14).

The detected COPCs responsible for the cancer risk estimate exceeding $1.0\text{E-}6$ at the three areas were heptachlor epoxide and beta-BHC (Table 5-15). Several semi-volatile organic compounds [benzo(a)pyrene, benzo(a)anthracene, and benzo(b)fluoranthene] and Aroclor 1260 were largely responsible for the higher total risk estimates from non-detected COPCs.

5.4.3.6 Ingestion of Surface Water. The risk estimates for ingestion of carcinogenic chemicals measured in surface water was less than $1.0\text{E-}6$ at all four areas for both adults and children (Table 5-16). The total HQ estimates were less than 0.05 for all four areas for both adults and children (Table 5-16). The carcinogenic risk from non-detected COPCs was up to several orders of magnitude higher than the carcinogenic risk from detected COPCs, due primarily to several semi-volatile organic compounds [benzo(a)pyrene, dibenzo(a,h)anthracene, and N-nitroso-di-n-propylamine].

5.4.3.7 Ingestion of Fish and Seals. The risk estimates for ingestion of carcinogenic chemicals in seal tissue were $5.42\text{E-}7$ and $8.43\text{E-}7$ for adults and children, respectively (Table 5-17). The risk estimates for ingestion of carcinogenic chemicals in fish tissue were $2.15\text{E-}13$ and $3.36\text{E-}13$ for adults and children,

TABLE 5-13. ESTIMATED RISK FROM DERMAL CONTACT WITH SOIL/SEDIMENT

Location	Receptor	Chemical	Risk Type	Soil Concentration (mg/kg)	Intake Factor (mg/kg/day)	Oral SF (mg/kg/day) ⁻¹	Cancer Risk (Dose x SF)
ADULT RISKS							
Soil							
West Drainage	Adult	Arochlor 1260	Carcinogenic	0.41	6.04E-6	8.56	3.16E-6
White Alice	Adult	Arochlor 1260	Carcinogenic	2.10	6.04E-6	8.56	1.63E-5
Sediment							
White Alice	Adult	Arochlor 1260	Carcinogenic	0.23	6.04E-6	8.56	1.78E-6
CHILD RISKS							
Soil							
West Drainage	Child	Arochlor 1260	Carcinogenic	0.41	4.34E-5	8.56	1.94E-6
White Alice	Child	Arochlor 1260	Carcinogenic	2.10	4.34E-5	8.56	1.00E-5
Sediment							
White Alice	Child	Arochlor 1260	Carcinogenic	0.23	4.34E-5	8.56	1.10E-6

TABLE 5-14. ESTIMATED RISK DUE TO DERMAL CONTACT WITH SURFACE WATER				
	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
<i>Dermal Contact with Surface Water</i>				
Beach Area	6.15E-13	0.01	3.79E-13	0.01
East Drainage	2.64E-5	0.87	1.63E-5	1.60
White Alice Area	7.45E-6	0.15	4.59E-6	0.27
West Drainage	5.51E-5	1.78	3.38E-5	3.31
NON-DETECTED COPCs				
<i>Dermal Contact with Surface Water</i>				
Beach Area	2.25E-7	0.01	1.39E-7	0.01
East Drainage	3.64E-4	0.85	5.63E-5	0.39
White Alice Area	3.64E-4	0.85	5.63E-5	0.39
West Drainage	3.64E-4	0.85	5.63E-5	0.39

TABLE 5-15. ESTIMATED RISK FROM DERMAL CONTACT WITH SURFACE WATER							
Location	Receptor	Chemical	Risk Type	Water Concentration (mg/L)	Intake Factor (mg/kg/day)	Oral SF (mg/kg/day) ⁻¹	Cancer Risk (Dose x SF)
ADULT RISKS							
White Alice	Adult	Heptachlor epoxide	Carcinogenic	2.00E-5	2.42E-2	9.1E+0	4.40E-6
White Alice	Adult	beta-BHC	Carcinogenic	7.00E-5	2.42E-2	1.8E+0	3.05E-6
West Drainage	Adult	Heptachlor epoxide	Carcinogenic	2.47E-4	2.42E-2	9.1E+0	5.40E-5
East Drainage	Adult	Heptachlor epoxide	Carcinogenic	1.20E-4	2.42E-2	9.1E+0	2.62E-5
CHILD RISKS							
East Drainage	Child	Heptachlor epoxide	Carcinogenic	1.20E-4	1.49E-2	9.1E+0	1.63E-5
West Drainage	Child	Heptachlor epoxide	Carcinogenic	2.47E-4	1.49E-2	9.1E+0	3.35E-5
White Alice	Child	Heptachlor epoxide	Carcinogenic	2.00E-5	1.49E-2	9.1E+0	2.71E-6
White Alice	Child	beta-BHC	Carcinogenic	7.00E-5	1.49E-2	1.8E+0	1.88E-6

TABLE 5-16. ESTIMATED RISK DUE TO INGESTION OF SURFACE WATER

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
<i>Ingestion of Surface Water</i>				
Beach Area	<1.0E-14	0.01	<1.0E-14	0.01
East Drainage	1.06E-7	0.01	1.64E-7	0.02
White Alice Area	2.98E-8	0.01	4.63E-8	0.01
West Drainage	4.54E-7	0.01	7.06E-7	0.04
NON-DETECTED COPCs				
<i>Ingestion of Surface Water</i>				
Beach Area	5.00E-9	0.01	7.77E-9	0.01
East Drainage	5.29E-6	0.04	8.24E-6	0.19
White Alice Area	5.29E-6	0.04	8.24E-6	0.19
West Drainage	5.27E-6	0.04	8.19E-6	0.19

TABLE 5-17. ESTIMATED RISK DUE TO INGESTION OF FISH AND MARINE MAMMALS

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
Fish	2.15E-13	0.01	3.36E-13	0.01
Seal	5.42E-7	0.01	8.43E-7	0.06
NON-DETECTED COPCs				
Fish	1.01E-10	0.01	1.57E-10	0.01
Seal	3.57E-4	0.82	5.56E-4	3.82

respectively (Table 5-17). The total of the estimated HQs for ingestion of non-carcinogenic chemicals in both seal and fish tissue were equal or less than 0.06 (Table 5-17). The total risk from non-detected COPCs was several orders of magnitude greater than the risk from detected COPCs, due primarily to several Aroclors and polycyclic aromatic hydrocarbons.

5.4.3.8 Ingestion of Berries. The risk estimates for ingestion of carcinogenic chemicals in berries at Kotzebue LRRS were less than $1.0\text{E-}6$ at all areas for both adults and children (Table 5-18). The total estimated HQs were 4.22 and 19.7 at the East Drainage area for adults and children, respectively, and less than 1 at all other areas. The total risk from non-detected COPCs was several orders of magnitude higher than the total risk for detected COPCs, particularly for the carcinogenic COPCs (Table 5-18).

The exceedance of the HQ threshold of 1 for the East Drainage area was due to 2-nitroaniline at 4.17 for adults and 19.5 for children (Table 5-19). The higher risk estimates for non-detected COPCs were due to as many as 10 different chemicals exceeding threshold values of 1 and $1.0\text{E-}6$, for non-carcinogenic and carcinogenic COPCs, respectively.

5.4.3.9 Ingestion of Caribou. The risk estimates for ingestion of carcinogenic chemicals in caribou tissue were $5.03\text{E-}9$ and $7.82\text{E-}9$ for adults and children, respectively (Table 5-20). The estimated HQs for ingestion of non-carcinogenic chemicals in caribou tissue were 0.01 for both adults and children. The total carcinogenic risk from non-detected COPCs was approximately 20 times higher than the risk for detected COPCs (Table 5-20).

5.4.4 Summary of Risk Estimates

Several of the exposure pathways evaluated at Kotzebue LRRS show the potential for some risk to humans as indicated by total carcinogenic risk estimates of greater than $1.0\text{E-}6$ or total non-carcinogenic HQ estimates of greater than 1 for detected COPCs. These pathways include inhalation of dust; ingestion of soil and sediment; dermal contact with soil, sediment, and surface water; and ingestion of berries. No potential risk was indicated from other dietary pathways such as ingestion of water, fish, seal, or caribou.

Table 5-21 shows the sum of the risk estimates calculated for all exposure pathways evaluated at each of the four investigative areas. The risk estimates for each investigative area include the risk estimate from the pathways that were evaluated using an EPC from the entire site (e.g., ingestion of caribou and inhala-

TABLE 5-18. ESTIMATED RISK DUE TO INGESTION OF BERRIES

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
<i>Ingestion of Berries</i>				
East Drainage	1.53E-7	4.22	2.39E-7	19.70
White Alice Area	6.39E-7	0.01	9.94E-7	0.01
West Drainage	3.87E-7	0.09	6.02E-7	0.40
NON-DETECTED COPCs				
<i>Ingestion of Berries</i>				
East Drainage	8.69E-4	7.07	1.35E-3	33.01
White Alice Area	1.98E-3	10.56	3.08E-3	49.30
West Drainage	1.08E-3	5.91	1.67E-3	27.60

TABLE 5-19. ESTIMATED RISK FROM BERRY INGESTION								
Location	Receptor	Chemical	Risk Type	Soil Concentration (mg/kg)	Calculated Berry Concentration (mg/kg)	Intake Factor (mg/kg/day)	Oral RfD (mg/kg/day)	Non-cancer Risk (Dose/RfD)
ADULT RISKS								
East Drainage	Adult	2-Nitroaniline	Non-Carcinogenic	1.16	9.48E-1	2.64E-4	6.00E-5	4.17E+0
CHILD RISKS								
East Drainage	Child	2-Nitroaniline	Non-Carcinogenic	1.16	9.48E-1	1.06E-4	6.00E-5	1.95E+1

TABLE 5-20. ESTIMATED RISK DUE TO INGESTION OF CARIBOU

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
Ingestion of Caribou	5.03E-9	0.01	7.82E-9	0.01
NON-DETECTED COPCs				
Ingestion of Caribou	1.17E-7	0.01	1.83E-7	0.01

**TABLE 5-21. SUMMARY OF COMBINED RISK ESTIMATES FOR
ALL EXPOSURE PATHWAYS FOR EACH INVESTIGATIVE AREA**

	ADULT EXPOSURE		CHILD EXPOSURE	
	Carcinogenic Risk	Non-Carcinogenic Risk	Carcinogenic Risk	Non-Carcinogenic Risk
DETECTED COPCs				
Beach Area	4.63E-6	0.026	8.11E-6	0.176
White Alice Area	3.57E-5	0.32	3.45E-5	0.707
East Drainage Area	4.20E-5	5.13	2.61E-5	21.8
West Drainage Area	6.41E-5	1.93	4.65E-5	3.98
NON-DETECTED COPCs				
Beach Area	3.61E-4	8.18	5.68E-4	26.6
White Alice Area	2.37E-3	18.9	3.19E-3	71.2
East Drainage Area	1.25E-3	15.3	1.43E-3	54.8
West Drainage Area	1.46E-3	14.2	1.76E-3	49.2

tion). For detected carcinogenic COPCs, the total risk ranged from $4.63\text{E-}6$ at the Beach area to $6.41\text{E-}5$ at the West Drainage area for adults, and from $8.11\text{E-}6$ at the Beach area to $4.65\text{E-}5$ at the West Drainage area for children. For detected non-carcinogenic COPCs, the total risk at the Beach area was again the lowest of the four areas (0.026 and 0.176 for adults, and children, respectively), while the highest total risk was at the East Drainage area (5.13 and 21.8 for adults and children, respectively) (Table 5-21). The total risk from non-detected COPCs was approximately 100 times greater than the total risk from detected COPCs.

A total of 36 detected COPCs were evaluated for this baseline human health risk assessment. Of this total, five chemicals (arsenic, Aroclor 1260, heptachlor epoxide, beta-BHC, and 2-nitroaniline) were detected at concentrations that resulted in risk estimates exceeding a cancer risk of $1.0\text{E-}6$ or a non-cancer risk of 1 for a particular exposure pathway. The locations of the individual samples that exceeded risk-based screening levels for these COPCs are shown in Table 5-22 and Figures 5-2 through 5-6. For each pathway of concern, only one or two COPCs exceeded the threshold risk values. For the soil/sediment ingestion pathway, arsenic and Aroclor 1260 both exceeded threshold risk values at one or more sites. Critical COPCs for the other pathways included Aroclor 1260 for dermal contact with soil, heptachlor epoxide and beta-BHC for dermal contact with surface water, 2-nitroaniline for berry ingestion, and arsenic for inhalation of dust (see Table 5-22).

A total of 26 samples from several different sites or AOCs had levels of arsenic in sediment or soil that resulted in a carcinogenic risk estimate of greater than $1.0\text{E-}6$ (see Table 5-22). This total included samples from three soil background areas (SS1, SS3, and SS4) and two sediment background areas (SD3 and SD4) (see Figure 5-6). In addition, two of the six soil samples analyzed for Aroclor 1260 with concentrations in exceedance of threshold risk values were also located at background locations. It can be argued that the contamination at background locations is likely not attributable to activities at Kotzebue LRRS, although one of the background samples (SS1) was collected from a location in the path of natural drainage from the White Alice area (see Figure 5-6).

The 19 non-background samples in which arsenic was detected at concentrations exceeding risk thresholds were located throughout Kotzebue LRRS, although they were mostly concentrated within the main complex between the East and West Drainage areas (see Figures 5-3 and 5-4). The critical concentrations of Aroclor 1260 were located primarily in the White Alice area (see Figure 5-2). Heptachlor epoxide

TABLE 5-22. LOCATION OF HUMAN HEALTH COPCs WHICH EXCEED
A 10^{-6} RISK VALUE OR A HQ OF 1 AT KOTZEBUE LRRS

Contaminant	Exposure Pathway			
	Soil/Sediment Ingestion	Dermal Contact	Berry Ingestion	Inhalation
2-Nitroaniline			SS08	
Arochlor 1260	SS11, AOC8	AOC8, SS11, SS12, SS1, SS4		
Arsenic	SS16, SS07, SD3, SD4, SS15, AOC7, AOC8, SS13, SS18, SS02, SS08, SS1, SS3, SS4			SS16, SS07, SD3, SD4, SS15, AOC7, AOC8, SS13, SS18, SS02, SS08, SS1, SS3, SS4
Heptachlor epoxide		SS07, SS11, SS12		
beta-BHC		SS11		

SS1, SS3, SS4 are background soil stations.

SD3, SD4 are background sediment stations.

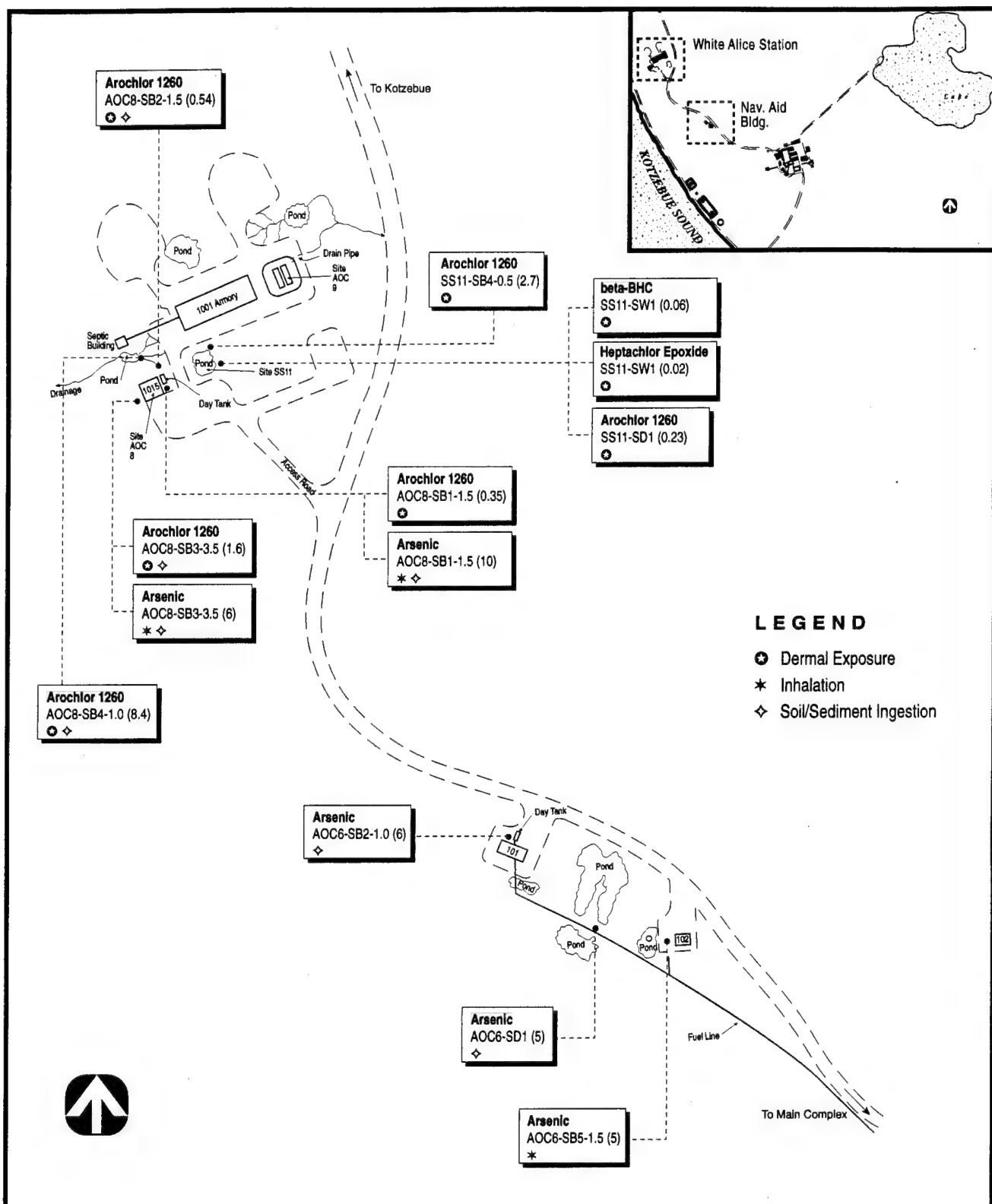


Figure 5-2. Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at the Navigational Aid Buildings and White Alice Area, Kotzebue LRRS, Alaska.

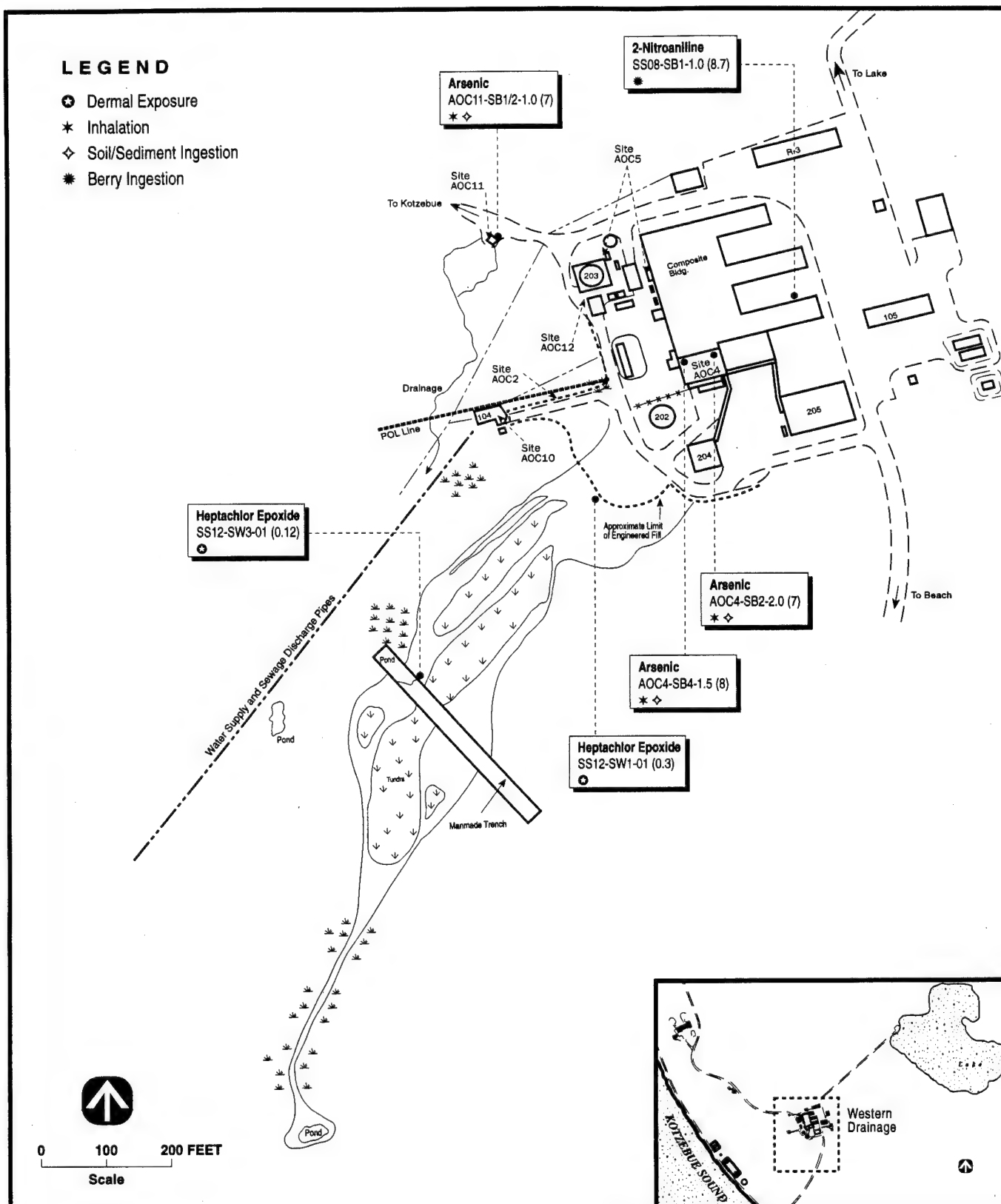


Figure 5-3. Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at the Western Drainage Area, Kotzebue LRRS, Alaska.

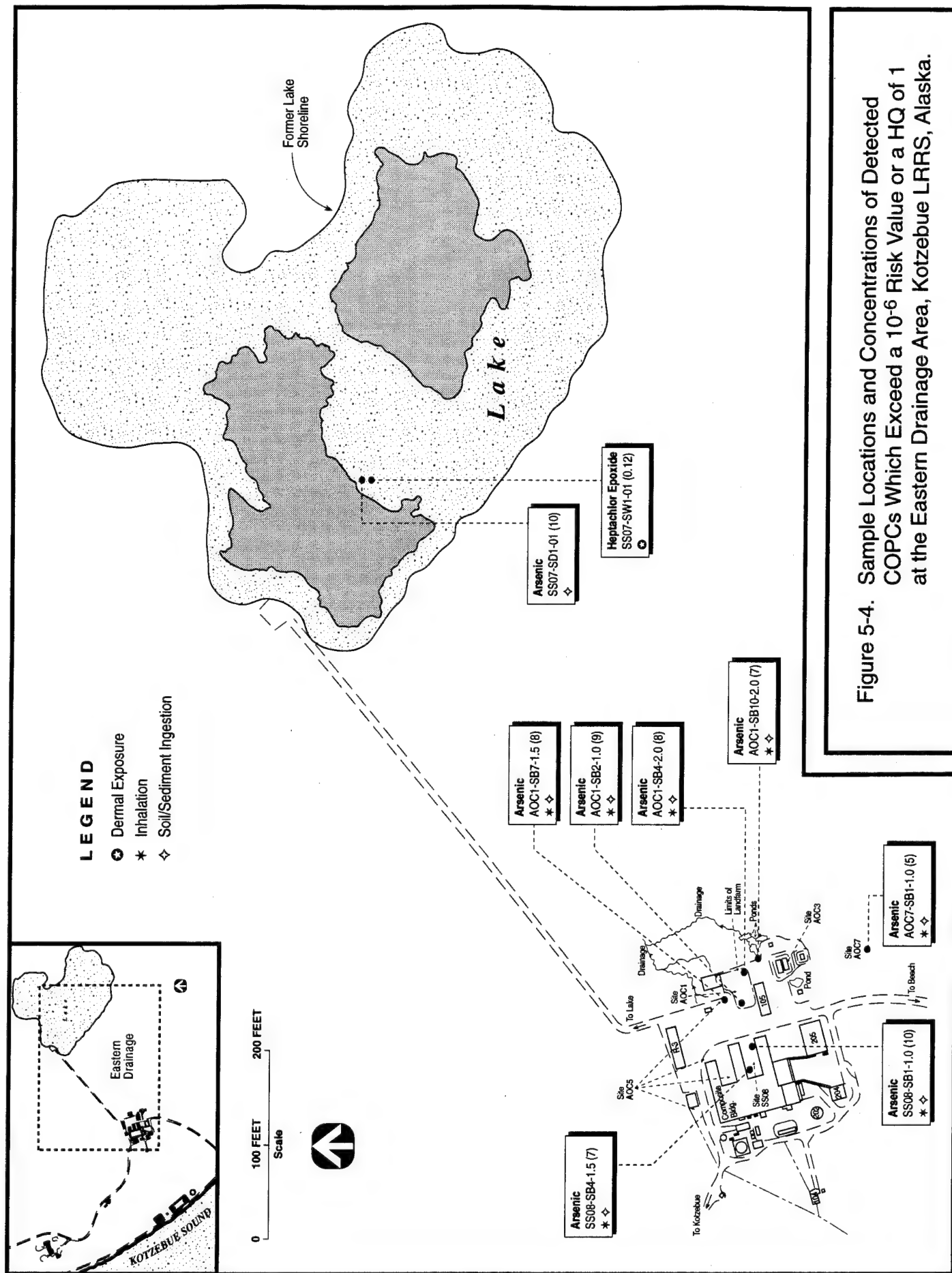


Figure 5-4. Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Risk Value or a HQ of 1 at the Eastern Drainage Area, Kotzebue LRRS, Alaska.

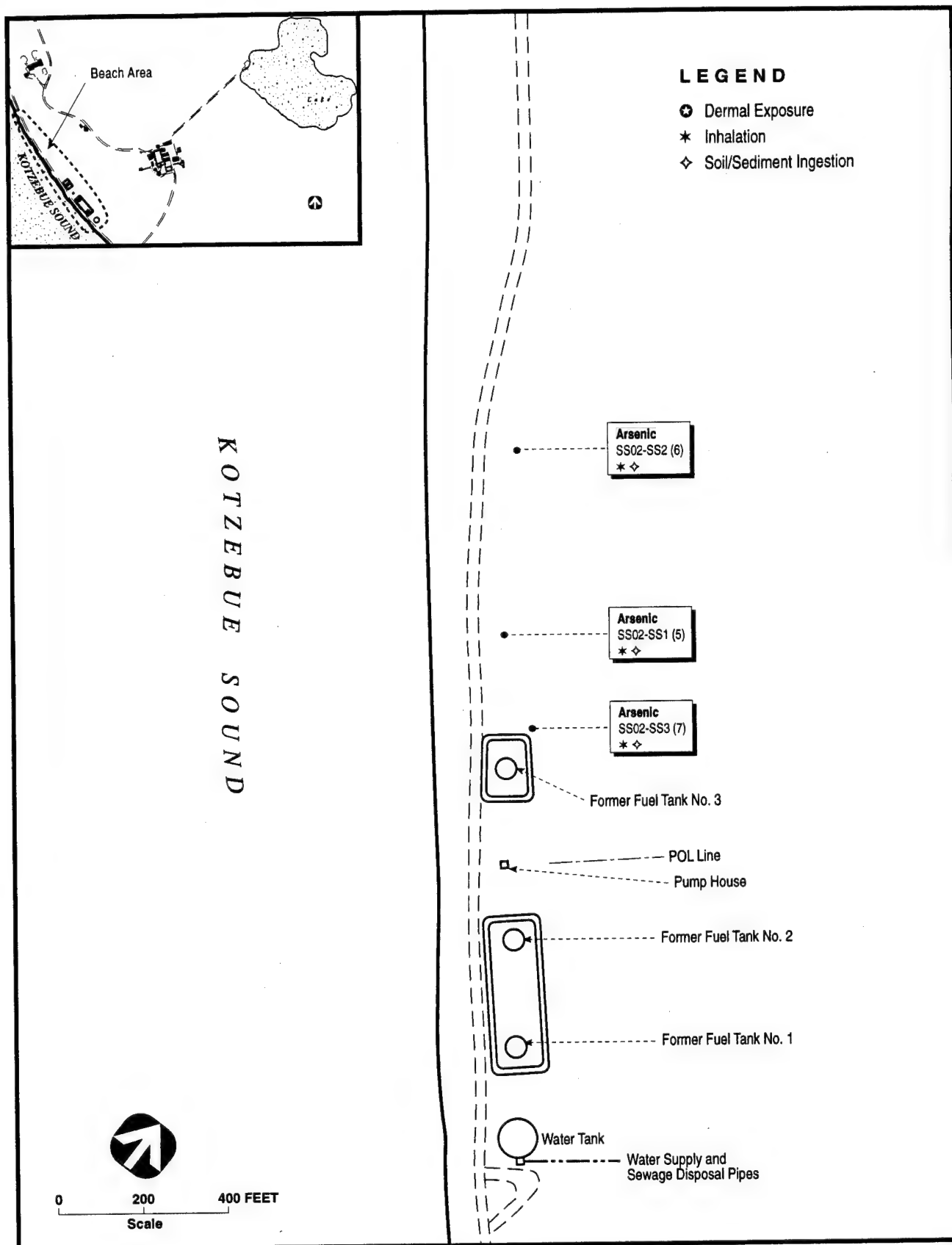


Figure 5-5. Sample Locations and Concentrations of Detected COPCs Which Exceed a 10^{-6} Value or HQ of 1 at the Beach Area, Kotzebue LRRS, Alaska.

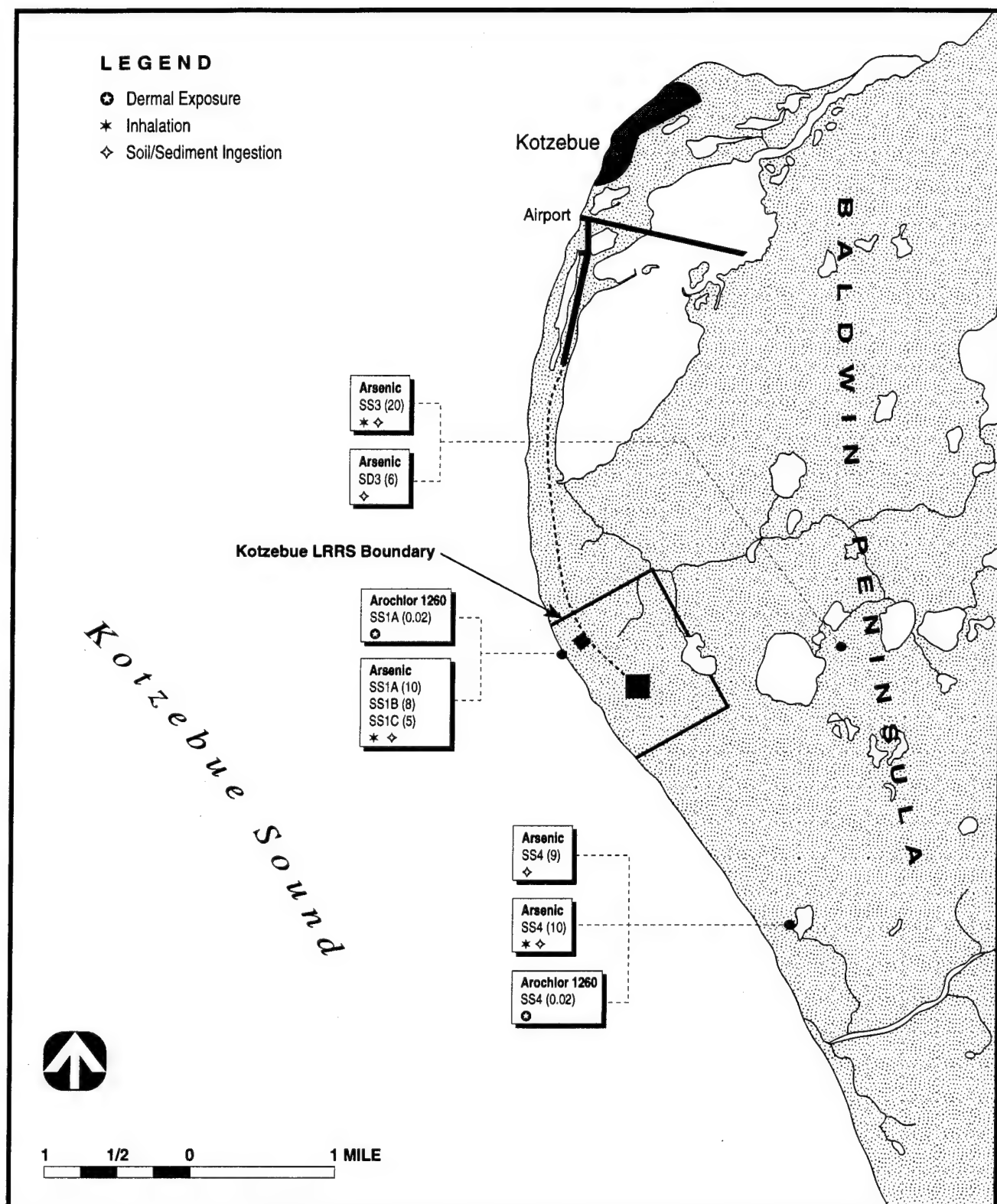


Figure 5-6. Sample Locations and Concentrations of detected COPCs Which exceed a 10-6 Risk Value or a HQ of 1 at the Background Sampling Stations, Kotzebue LRRS, Alaska.

was detected in surface water samples at concentrations exceeding $1.0E-6$ risk from two sites in the West Drainage area (see Figure 5-3) and from the former water supply lake (see Figure 5-4). A single surface water sample analyzed for beta-BHC at Site SS11 exceeded a cancer risk of $1.0E-6$ (Figure 5-2). A single soil sample analyzed for 2-nitroaniline at Site SS08 exceeded an HQ of 1 (see Figure 5-3).

5.5 UNCERTAINTY ANALYSIS

Throughout this baseline human health risk assessment for Kotzebue LRRS, U.S. EPA standard default exposure values were used for the majority of exposure parameters unless site-specific information was available. The default exposure values are intended to reflect upper bound estimates for various activities to avoid underestimation of chemical exposure and consequent health risks. Where there was a lack of default values and site-specific information, estimates based upon conservative assumptions were derived. It is likely that the use of conservative assumptions resulted in an overestimate of exposure and the potential for human risk. By using this approach, seven exposure pathways demonstrated a potential for human health risk: soil and sediment ingestion; dermal contact with soil, sediment, and surface water; inhalation of dust; and consumption of berries. A discussion of the conservative assumptions used in the quantification of risk is presented below.

5.5.1 Representative Exposure Concentrations

Exposure point concentrations in the four media sampled were based on the 95% UCL of the mean (except in cases where the 95% UCL exceeded the maximum, in which case the maximum concentration was used), with half of the PQL used for samples in which the chemical was not detected. The use of the UCL and PQL takes into account the number of samples and the variability in the detected values. Therefore, the exposure estimates are based on reasonable maximum exposure concentrations.

Following U.S. EPA (1989a) guidance, estimated data values (i.e., J and UJ qualified data) were used in the risk evaluations. As discussed in Section 4.1, the uncertainties associated with these data may be reflected in the final risk estimates.

For the marine environment, chemical concentrations in surface water were derived from detected groundwater values using a near-field dilution value. This dilution value, calculated from a model which

estimated the volume flux of groundwater and seawater at the beach area, was conservative because it assumed a near-field dilution while overall dilution includes both near-field and far-field components. The dilution estimate is based on volumetric estimates of groundwater and ocean water flux. The estimate of ocean water flux is the more uncertain of the two flux estimates since it is based in part on the geometric shape of Kotzebue Sound as determined from navigational charts and not on empirical data collected in the field. Nonetheless, there is the potential for an additional 100-fold increase in dilution due to far-field effects.

The EPCs used for the direct exposure pathways (e.g., contact with soil, sediment, or surface water) are based on measured values. The EPCs associated with the indirect pathways (e.g., consumption of animals and plants) are based on several modeling assumptions, such as bioconcentration factors, biotransfer factors, food chain multipliers, and stem concentration factors (see Tables 5-3 and 5-4). As such, the concentrations in animals and plants are subject to a greater uncertainty than the concentrations in soil, sediment, surface water, and groundwater. Biotransfer factors for the calculation of concentrations into animal species assumes that the flux of contaminants between the animal and the contaminated source has reached equilibrium, which may not be the case because neither caribou nor the marine species (chum salmon, sheefish and bearded seal) are found in the area year-round. Thus, the application of the BTF value used in this exposure assessment may have overestimated chemical concentrations in these animal tissues.

5.5.2 Exposure Assumptions

It was assumed that recreational and subsistence users who frequent the site are exposed to contaminants every day during the four summer months. This may overestimate the risk due to the fact that there are no residences on site, and recreational users may only frequent the site on the weekends during the summer months.

Relatively few studies have been performed on the evaluation of chemical absorption by the skin, particularly chemicals that occur in a soil matrix. Volatilization, friction, and washing may remove some fraction of the chemical before it can be absorbed through the skin. By assuming a constant absorption fraction for chemicals associated with soils and sediments, the amount of chemical absorbed by an individual may have been overestimated.

No significant risk was predicted for the consumption of potentially contaminated species harvested at the Kotzebue LRRS. Several conservative assumptions were made, all of which would tend to overestimate exposure and risk. Food consumption estimates were based on the amount harvested, which is not necessarily identical to the amount consumed. Harvest data also include animals taken for subsistence living (e.g., hide for clothing, trade and barter) and for commercial profit. Additionally, it was assumed that both adults and children have similar consumption rates and that consumption of contaminated plants or animal species occur 365 days a year, which allows for harvesting and preserving the potentially contaminated foodstuff. The soil concentrations used to derive the estimated COPC concentrations in berries were not limited to areas where berries are known to exist (see Figures 4-2, 4-4, and 4-5). Thus, the estimated risk from berry ingestion was probably overestimated.

5.5.3 Toxicity Evaluations

Toxicity criteria for most of the COPCs are based on animal studies. The U.S. EPA specifically acknowledges this uncertainty in the reference dose data by including uncertainty or modifying factors to adjust animal data to values potentially representative of human levels of concern (see Tables 5-5 and 5-6). Toxicity criteria may overestimate or possibly underestimate the magnitude of potential adverse health effects associated with a given level of chemical exposure.

For the dermal exposure pathway, oral SFs and RfDs were adjusted by an oral absorption efficiency to account for the difference between an orally administered and a dermally absorbed dose. There is a considerable amount of variability between oral and dermal exposure, thus the application of oral dose-response relationships to dermal doses must be regarded with caution. The most conservative (largest) experimental oral absorption efficiencies from the literature were used. If experimental data were not available for a given chemical, a theoretical absorption efficiency of 1 was used. Because many of the absorption efficiencies used in this baseline risk assessment were very close to or equal to 1, the risk from the dermal exposure pathway was probably overestimated.

Toxicity criteria are not available for several of the chemicals detected at Kotzebue LRRS (e.g., delta BHC, 2-methylnaphthalene, 2-nitrophenol, and phenanthrene). As a result of these data gaps, additional uncertainty was introduced in the final risk estimates.

6.0 BASELINE ECOLOGICAL RISK ASSESSMENT

This section presents the baseline ecological risk assessment and includes separate subsections for selection of contaminants of potential ecological concern (COPEC), ecological characterization, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis.

6.1 CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN

Because contaminants at Kotzebue LRRS are not limited to a particular class of chemical and many different compounds were detected during the 1994 RI (USAF 1995a), a screening assessment was performed to identify COPECs. The screening is described in Section 6.1.1, followed by a presentation of the COPC concentrations for the reasonable maximum exposure (RME) scenario in Section 6.1.2.

6.1.1 Screening Assessment

A screening of the contaminant results was performed to determine which chemicals might pose a potential risk to ecological receptors. The screening was very similar to that performed for the human health baseline risk assessment (see Section 5.1.1). The screening consisted of the following four steps: 1) compare maximum detected concentration for each chemical in each medium with screening concentrations, 2) compare maximum PQLs to screening concentrations for chemicals which were not detected, 3) identify organic chemicals which were detected but for which no screening concentrations are available, and 4) compare maximum concentrations to mean background concentrations for metals without screening concentrations. Each of these steps is described in greater detail below.

Screening concentrations consisted of both surface water criteria and sediment quality guidelines, both of which are intended to be protective of aquatic organisms which are present in these media. Surface water quality criteria (the lower of the acute or chronic fresh water values) promulgated by U.S. EPA (1991d) were used to evaluate both surface water and groundwater contaminant concentrations at

Kotzebue LRRS. Sediment quality guidelines were obtained from several sources, including *Adverse Effects to Benthic Organisms in Sediment* (Long and Morgan 1990), *Ontario Aquatic Sediment Quality Guidelines* (Persaud et al. 1993), and *Sediment Criteria for New York State* (Newell and Sinnott 1993). U.S. EPA sediment quality criteria were not used because lower (more conservative) values have been published in the above sources. For a given chemical, the lowest concentration from the above three sources was used as the screening concentration for both sediment and soil concentrations at Kotzebue LRRS. Sediment guidelines were used for soil concentrations because soil quality guidelines are not available. The screening concentrations used at Kotzebue LRRS are given in Appendix Table B-3. The maximum concentration for each chemical in each medium was compared to the appropriate screening concentration. If the maximum concentration exceeded the screening concentration, the chemical was considered a COPEC and was carried through the baseline ecological risk assessment. For chemicals which were not detected at Kotzebue LRRS, an additional screening was performed to determine if the PQL exceeded the screening concentration. If the maximum PQL for a chemical in a particular medium exceeded the appropriate screening concentration, that chemical was added to the list of COPECs. Because the risk attributed to COPECs which were not detected is less certain than risk attributed to detected COPECs, the two groups of chemicals were evaluated separately. If neither the maximum detected concentration or the maximum PQL exceeded the screening concentration, that chemical was not considered a COPEC and was not evaluated further.

Screening concentrations were not available for approximately half the chemicals measured at Kotzebue LRRS. Organic chemicals in this category were added to the list of COPECs if they were detected at Kotzebue LRRS. Exceptions to this rule were made for the TPH fractions (diesel and gasoline) because toxicity data for the weathered fuels typical of TPHs are not available. Ecological risk due to hydrocarbons was assessed by characterizing the risk from the semi-volatile and volatile organic compounds which make up TPH. Metals in this category were added to the list of COPECs if they were detected at greater than 3X the mean background concentration for a particular medium. The list of COPECs for each medium is given in Table 6-1. A total of 67 COPECs were identified using the approach described above. Within each of the four media, the number of COPECs ranged from 28 for sediment to 41 for soil.

6.1.2 COPEC Concentrations for Reasonable Maximum Exposure Scenario

The RME scenario is a conservative approach whereby the exposure point concentration (EPC) that a particular animal is likely to be exposed to is defined as the 95 percent upper confidence limit (UCL) of

**TABLE 6-1. CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN (COPEC) BY MEDIA
AT KOTZEBUE LRRS, ALASKA (Page 1 of 2)**

Chemical	Media			
	Sediment	Soil	Surface Water	Ground Water
<i>Metals</i>				
Antimony	2	1		
Barium			4	
Cadmium	2	2	2	2
Lead		1		
Magnesium			4	
Manganese			3	3
Mercury			1	1
Selenium			2	
Silver	1		2	2
<i>Pesticides/PCBs</i>				
4,4'-DDT	1		1	1
Arochlor 1016	2	2	2	2
Arochlor 1221			2	2
Arochlor 1232			2	2
Arochlor 1242			2	2
Arochlor 1248			2	2
Arochlor 1254			2	2
Arochlor 1260	1	1	2	2
Dieldrin	1	1	1	2
Endosulfan Sulfate			3	
Endrin	1	1	2	2
Endrin Aldehyde		3		
Heptachlor			1	2
Heptachlor Epoxide			1	2
Methoxychlor			2	2
Toxaphene	2	2	2	2
alpha-Chlordane			2	2
alpha BHC			3	
delta BHC			3	
gamma-Chlordane	1		2	2
<i>Semi-volatile Organics</i>				
2,4-Dichlorophenol		3		
2,4-Dinitrotoluene		3		
2,6-Dinitrotoluene		3		
2-Methylnaphthalene	2	1		3
2-Nitroaniline		3		
2-Nitrophenol		3		
4-Methylphenol	3	3		3
4-Nitroaniline		3		
4-Nitrophenol		3		
Acenaphthylene				3
Anthracene	2	1		
Benzo(b)fluoranthene	2	1		
Benzo(g,h,i)perylene	2			
Benzo(k)fluoranthene	2	2		
Benzoic Acid	3	3		3

**TABLE 6-1. CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN (COPEC) BY MEDIA
AT KOTZEBUE LRRS, ALASKA (Page 2 of 2)**

Chemical	Media			
	Sediment	Soil	Surface Water	Ground Water
Butylbenzylphthalate		3		
Dibenzo(a,h)anthracene	2	2		
Dibenzofuran		3		3
Diethyl Phthalate				2
Dimethylphthalate		3		
Fluorene	2	1		3
Hexachlorobutadiene	2			
Hexachlorocyclopentadiene			2	2
Isophorone		3		
Phenol		3		
di-n-butyl Phthalate		3		2
<i>Volatile Organics</i>				
1,1,2-Trichloro-1,2,2-trifluoroethane	3	3		
1,1-Dichloroethene	2	2		
2-Hexanone		3		
Acetone	3	3	3	3
Carbon Disulfide				3
Chloroform		3		
Ethylbenzene	3	3		
Methyl Ethyl Ketone (2-butanone)	3	3	3	3
Methylene Chloride	3	3	3	
Toluene	3	3		
Xylenes, total	3	3		3
cis-1,2-Dichloroethylene		3		
Key: 1 = Detected concentration exceeded screening value 2 = Practical Quantitation Limit (PQL) exceeded screening value 3 = No screening value available; chemical was detected 4 = No screening value available; metal detected > 3X mean background concentration				

the available sampling data for each investigative area/medium combination (U.S. EPA 1991c). In cases where the 95 UCL exceeds the maximum concentration, which is possible given a highly variable group of data points, the maximum concentration is used for the EPC. The EPCs for each of the COPECs given in Table 6-1 are given in Appendix Table B-4. For COPECs which were not detected, one-half the PQL was used for the EPC, as suggested in U.S. EPA (1991c).

6.2 ECOLOGICAL CHARACTERIZATION

This section provides an overview of the ecological communities found within Kotzebue Sound and on the Baldwin Peninsula. General trophic level groups (e.g., plankton, piscivorous fish) are described for the marine, freshwater, and terrestrial environments. Factors relevant to the selection of the key receptor species to be evaluated in the ecological risk assessment (e.g., ecological importance, endangered or threatened species, subsistence use) are also summarized. Important trophic relationships among the organisms identified are summarized. Species potentially present in the Kotzebue vicinity are listed in Appendix G.

6.2.1 Marine Communities

The marine ecological community of Kotzebue Sound is composed of organisms ranging from phytoplankton and zooplankton which form the base of the food chain to some of the largest carnivores, the marine mammals. The components of the major marine community groups are summarized below.

6.2.1.1 Plankton. Phytoplankton and zooplankton are the most vital components of the pelagic marine community as these two groups provide the food base for other groups of marine organisms found within the sound. In addition, larval stages of many benthic organisms and fish species are temporary members of the plankton (meroplankton) during early stages of development. The distribution and abundance of these organisms is strongly influenced by the physical environment, specifically by the seasonal occurrence of open water leads in Kotzebue Sound. Although these organisms form the basis of the marine food web, they are relatively abundant and widely distributed.

6.2.1.1.1 Phytoplankton. There are two groups of phytoplankton in Kotzebue Sound—an ice-associated flora (epontic algae) that grow attached to the undersurface of the ice during spring—and

phytoplankton suspended in open water during summer. However, there is very little information available on phytoplankton and primary productivity in Kotzebue Sound (Schell et al. 1988). Studies conducted in the high Arctic and in the Chukchi Sea near Barrow indicate that the epontic algal community is dominated by shade-adapted pennate diatoms. Annual primary production estimates made at these two locations ranged from 5 to 13 g C/m². Primary production of phytoplankton in the open water of the southern Chukchi Sea, and presumably for Kotzebue Sound, is relatively high (75-100 g C/m²-yr) due to the advection of upwelled nutrient-rich water from the Gulf of Anadyr through the Bering Strait.

6.2.1.1.2 Zooplankton. Zooplankton production is generally coupled to phytoplankton production. Field sampling studies of zooplankton conducted in Kotzebue Sound have been summarized by Hameedi (1988). In general, zooplankton biomass and species composition was reduced in Kotzebue Sound relative to samples collected in the Chukchi Sea and the Bering Strait. Zooplankton species identified in Kotzebue Sound in 1976 are shown in Appendix Table G-1. Numerically dominant zooplankton identified within Kotzebue Sound include the urochordate *Fritillaria borealis* and the cladoceran *Evadne* sp. Biomass data indicate that zooplankton biomass in the southeastern Chukchi Sea ranges between 100 and 1,000 mg/m³. Although not reported for Kotzebue Sound, freshwater zooplankton species such as *Daphnia* sp. have been reported from estuarine lagoons along the north coast of the Chukchi Sea. Freshwater zooplankton species may also occur seasonally in Kotzebue Sound near the mouth of the Noatak River and Hotham Inlet (Kobuk Lake).

6.2.1.2 Aquatic Plants and Attached Algae. No descriptions are available of the attached marine algae and marine angiosperms in Kotzebue Sound. However, eelgrass (*Zostera marina*) likely occurs in shallow areas at suitable locations within the sound. Attached filamentous algae also likely occur in shallow waters during the summer. These plants and attached algae are important food sources for a variety of nearshore marine life, including benthic invertebrates and small herbivorous fishes.

6.2.1.3 Benthic Invertebrates. Benthic invertebrates are generally secondary consumers that utilize the energy available from the primary production of phytoplankton, attached algae, and macrophytes. Some benthic invertebrates are also detritivores and scavengers that utilize organic detritus and decaying carcasses as a food source. In general, the distribution, abundance, and seasonal variation of benthic species in Kotzebue Sound is dependent on physical and biological factors. Physical factors include ice gouging and sediment composition. Species composition and productivity of these benthic organisms is

strongly controlled by the input of organic matter from the overlying water. Predation on marine benthos by marine mammals [e.g., gray whale (*Eschrichtius robustus*), Pacific walrus (*Odobenus rosmarus*), and bearded seal (*Erignathus barbatus*)] may also be important to the extent that these animals feed within Kotzebue Sound. Data on benthic invertebrates within Kotzebue Sound are limited, but these data have been summarized by Feder and Jewett (1988). Benthic infauna sampled at two shallow, muddy stations in outer Kotzebue Sound were dominated by *Nuculana fossa* (clam), *Seripes groenlandicus* (cockle), *Cucumaria* sp. (sea cucumber), and *Sternaspis scutata* (polychaete worm). The infaunal biomass ranged from 68 to 592 g/m² and the faunal abundance from 796 to 958 individuals/m². Epifaunal biomass measured over the southeastern Chukchi Sea, including Kotzebue Sound, averaged 3.3 g/m². Echinoderms (primarily sea stars) dominated the biomass, followed by molluscs and arthropods (Appendix Table G-2). A sea urchin (*Strongylocentrotus droebachiensis*), two crabs (*Chionoecetes opilio* and *Hyas coarctatus aleutaceus*), and a marine snail (*Neptunea heros*) were also relatively abundant at a number of locations in Kotzebue Sound. Sea stars generally feed on the small clams, while the sea urchin feeds on sessile epifauna attached to rocks. Crabs are opportunistic feeders that may consume a diverse array of prey organisms. Snails are common in locations with soft-bottom substrates and feed on polychaetes and small bivalves.

Although the potential exists for commercial and subsistence exploitation of benthic species, especially the Tanner crab (*C. opilio*), benthic species are currently not heavily utilized commercially or for local subsistence (Georgette and Loon 1993). This includes the limited numbers of clams, mussels, and shrimp that are available within the sound.

6.2.1.4 Fishes. The fish species of Kotzebue Sound are perhaps the best studied biological resource. This is due to locally important commercial and subsistence fisheries within the sound, primarily for chum salmon (*Onchorynchus keta*), Pacific herring (*Clupea harengus pallasii*), and saffron cod (*Eleginus gracilis*). Other important fishes which are harvested for subsistence purposes include Dolly Varden (*Salvelinus malma*), sheefish (*Stenodus leucichthys*), and species of whitefish (*Coregonus* spp.). Fishes in Kotzebue Sound feed on a variety of organisms including benthic invertebrates, attached algae, zooplankton, and other fish. A listing of fish species found in Kotzebue Sound is provided in Appendix Table G-3.

In general, fish population densities are lower in offshore waters than in inshore waters during summer in Kotzebue Sound (Raymond 1988). The results of investigations of summer fish populations in near-shore areas of Kotzebue Sound have been summarized by Raymond et al. (1984). Juvenile chum salmon were abundant in June and early July between Sadie Creek and the northern tip of the Baldwin Peninsula, but were rare outside this area. Whitefishes, ciscoes, starry flounder, and juvenile smelts were the most frequently caught and therefore the most widely distributed species in summer. Species with the highest estimated abundance were saffron cod, whitefishes, and Pacific herring. The whitefishes were of three distinct species, with the humpback whitefish (*C. pidschian*) being the most abundant. The whitefishes were primarily found in two length ranges: juveniles in the 2- to 5-cm range and adults in the 15- to 30-cm range. Two species of ciscoes have been identified, with the least cisco (*C. sardinella*) being the most abundant. The lengths of ciscoes that were caught ranged from 2 to 30 cm. Three rainbow smelt species have been identified and rainbow smelt (*O. mordax*) was by far the most abundant. Most of the smelts captured were juveniles in the 1.5- to 6-cm range, while some larger smelts ranged from 8 to 20 cm in length. Saffron cod were distributed throughout nearshore areas of Kotzebue Sound and their sizes ranged from 2 to 35 cm. Pacific herring were typically collected in large schools. The herring that have been collected ranged in two size classes: 1- to 9-cm juveniles and 14- to 26-cm adults. The starry flounder caught ranged in length from 4 to 35 cm, with most falling in the 9- to 15-cm range. Although sheefish were collected in relatively small numbers, they were the largest of the nearshore fishes that were caught and ranged in length from 20 to 75 cm.

Raymond et al. (1984) also reported the infrequent occurrence of pink salmon (*O. gorbuscha*). Small numbers of chinook (*O. tshawytscha*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon have also been reported to occur in Kotzebue Sound (Georgette and Loon 1993).

6.2.1.5 Birds. Seasonally, several million seabirds, waterfowl, and shorebirds belonging to more than 80 species are found in the Chukchi Sea region. These birds feed on small fish in open water and on small benthic invertebrates in nearshore areas.

Reported bird densities in Kotzebue Sound have been relatively low, 2.7 birds/km² (1.1 birds/mi²) (Divoky and Springer 1988). Black-legged kittiwakes were the most abundant species found, followed closely by phalaropes (Appendix Table G-4). Many of the seabird species form large breeding colonies of 10⁵ to 10⁶ birds along rocky cliffs that serve as protection from predators such as the Arctic fox.

However, large seabird colonies within Kotzebue Sound are found far to the south of the radar station (ca. 50 mi) at locations such as Puffin Island, Chamisso Island, Rex Point, Toawlevic Point, and Cape Decept. The total number of colonial seabirds at 16 locations in Kotzebue Sound has been estimated at 500,000. Large seabird colonies also are found along the cliffs of Cape Thompson, Cape Lisburne, and Cape Hope, more than 100 mi northwest of the radar station.

Shorebirds that prefer coastal lowland tundra, mudflats, and saltmarshes also occur along the shores of Kotzebue Sound where these habitats are found. Suitable habitat for shorebirds include the mouth of the Noatak River, the north coast of the Seward Peninsula, and the vicinity of Cape Espenberg. The salt marsh and mud flat areas of Cape Krusenstern also attract large numbers of migrating shorebirds and waterfowl.

6.2.1.6 Mammals. Several species of marine mammals may be found seasonally in Kotzebue Sound (Appendix Table G-5). These species include pinnipeds such as the ringed, bearded, and spotted seals; cetaceans such as Pacific walrus, harbor porpoise, and killer, gray, belukha, bowhead, and minke whales; and polar bears. The existing data on the biology and distribution of marine mammals in Kotzebue Sound has been reviewed by Frost and Lowry (1988). Belukha whales are perhaps the most common summer marine mammal residents of Kotzebue Sound. Belukha whales are not uncommon during light ice conditions during winter and as leads begin to form along the coast, they migrate north to feed on salmon and cod in shallow bays and estuaries of large rivers, including those found in Kotzebue Sound. Belukha whales are especially common in the vicinity of the Noatak River to the north and Eschscholtz Bay (the mouth of the Buckland River) in southern Kotzebue Sound, where they feed on saffron cod, sculpins, Pacific herring, smelt, capelin, salmon, char, shrimp, and octopus, depending on the seasonal abundance of these prey species. Calving also occurs during the feeding period April-August, with a peak in June and July. The peak number of belukha whales in Kotzebue Sound during summer varies from year to year, but has ranged from 500 to more than 2,000. By September, these whales begin to move southward as leads begin to close as winter approaches.

The remaining marine mammal species, with the exception of killer whales that hunt belukha whales in Kotzebue Sound during summer, are generally infrequent visitors to the sound.

6.2.2 Freshwater Communities

The freshwater communities of the Baldwin Peninsula are typified by shallow ponds surrounded by emergent aquatic vegetation and wetlands at their edges. Because of long winters with freezing temperatures, many of these ponds do not support fish. The organisms that do live there typically have an overwintering stage which flourishes and reproduces during the short summer. Because descriptions of freshwater habitats of the Baldwin Peninsula are not available, most of the description of these communities is necessarily adapted from descriptions of tundra ponds of the Arctic Coastal Plain (Hobbie 1984).

6.2.2.1 Plankton. In general, the plankton of Arctic ponds are the same species that are commonly found in temperate waters. The phytoplankton present are typically small single-celled species of *Ochromonas*, *Rhodomonas*, or *Cryptomonas*. Although production by these algae is relatively high, the ponds are so shallow and the growing season so short that annual production may be limited to 1-2 mg C/m². Phytoplankton production is limited by the nutrient phosphorus.

Although phytoplankton production is relatively high, phytoplankton biomass in Arctic ponds is typically low—less than 5 µg/L. This is because the phytoplankton are rapidly grazed by zooplankton. The herbivorous zooplankton species include species of *Daphnia*. Predaceous species that feed on herbivorous zooplankton may also be present, including species of *Heterocope* and *Cyclops*.

6.2.2.2 Benthic Invertebrates. Benthic invertebrates are very important to the ecology of freshwater ponds. These invertebrates are extremely productive and provide food for birds and other pond organisms. The dominant organisms are Chironomidae (midge larvae), which include species of *Chironomus*, *Procladius*, and *Tanytarsus*. Oligochaete worms (e.g., *Tubifex*) may also be common. Most of these organisms are detritivores and deposit feeders.

Chironomids are probably the most important organism. The total numbers of larvae can reach 15,000 m⁻² and as many as 5,000 adults per m² can emerge in a single season. Production estimates are on the order of 1 g/m²-yr.

6.2.2.3 Aquatic Plants. Aquatic plants include species of benthic algae and submergent and emergent aquatic plants. Benthic algae include filamentous forms of green algae (Chlorophyta) and blue-green algae (Cyanophyta). Benthic diatoms may also be abundant. Benthic algae are generally more productive

than phytoplankton, with production estimates ranging from 10 to 410 g C/m². Phosphorus is also limiting to the growth of benthic algae. Very little of the benthic algal production is consumed by benthic grazing organisms. The detritus formed from the algae contributes to the accumulation of organic matter in the sediments.

Emergent plants include species of sedge (*Carex*) and the pendant grass (*Arctophila fulva*). Other aquatic species include *Hippuris vulgaris*, *Caltha palustris*, *Cardamine pratensis*, *Ranunculus pallasii*, *Utricularia intermedia*, *Sparganium minimum*, and the mosses *Drepanocladus* and *Scorpidium scorpiodes*.

6.2.2.4 Birds. Many of the birds that use freshwater habitats in the vicinity of the radar station are migratory and many are important subsistence species. Many of these birds feed on benthic invertebrates in pond sediments and on zooplankton in the water column. These birds include wading shorebirds, particularly sandpipers and the dunlin. Sandpipers and dunlins typically feed on exposed sediments rather than in ponds and lakes. Phalaropes, both red and northern, are also common. These birds feed on the zooplankton and benthic invertebrates that they stir up by their characteristic swimming behavior. Ducks, geese, loons, and the sandhill crane may also make use of ponds for food and breeding.

6.2.3 Terrestrial Communities

The terrestrial community of the Baldwin Peninsula is supported by tundra vegetation, the extensive aquatic and wetland habitats, and the close connection of the peninsula to Kotzebue Sound. The components of the major terrestrial community groups are summarized below.

6.2.3.1 Plants. The tundra vegetation of the Baldwin Peninsula is the product of the combination of permafrost and cool weather, which reduces the extent of evaporation. These factors combine to favor herbaceous species and low shrubs with shallow roots that are adapted to wetland terrain. Shrubs are favored in locations where drainage and the depth of frozen ground combine to allow deeper penetration of roots. The predominant vegetation type of drier upland areas is cotton grass (*Eriophorum angustifolium*), which forms dense tussocks. In wetter areas, species of sedge (*Carex* spp.) and horsetail rush (*Equisetum* spp.) are found, as well as a number of ericaceous plants (e.g., *Ledum* sp.). The ground is covered with a variety of edible plants which are harvested by the local community for subsistence consumption (Appendix Table G-6). Because of the relatively small numbers of herbivores, the decaying

plants supply organic matter to a detrital food web and contribute to the accumulation of peat. However, plant roots, seeds, and berries are an important source of food for a number of small mammals and birds.

6.2.3.2 Birds. Due to the close connection of the terrestrial environment to Kotzebue Sound and the wetland habitats, it is difficult to identify birds that may be considered strictly terrestrial. A number of migrating species nest in the tundra and a few resident species such as the raven, ptarmigan, and snowy owl may be considered strictly terrestrial species. Some of these birds are scavengers (e.g., ravens), others feed on terrestrial insects, and others rely on nearby marine and aquatic habitats for food.

6.2.3.3 Mammals. A number of terrestrial mammals may occur in the vicinity of the radar station, including species of predatory animals such as fox and wolf or species of small herbivores such as voles and ground squirrels (Appendix Table G-7). Perhaps the most abundant species of terrestrial mammal in the vicinity of the radar station is the Arctic ground squirrel, which inhabits burrows and pipes on the grounds of the station. These animals are herbivores that feed on roots and seeds and collect and store these foods for the long winter.

Larger herbivorous mammals, such as moose and caribou, inhabit Baldwin Peninsula seasonally. Barren-ground caribou have included the peninsula on their migration route to and from their calving grounds north of the Noatak River and their wintering grounds south of the Kobuk River in each of the last three seasons (Erlick, J., 17 January 1995, personal communication).

6.2.4 Selection of Key Ecological Receptors

Based on the available ecological information concerning species present in the Kotzebue area and the importance of some species in the terrestrial ecosystem and for subsistence usage, the three key receptor species selected for this baseline ecological risk assessment are the ringed seal for the marine environment and the Arctic ground squirrel and the caribou for the terrestrial environment. The criteria for selecting the receptor species to be evaluated included: 1) its ecological importance in the ecosystem, 2) its abundance in the Kotzebue vicinity, 3) its importance for recreational/subsistence activities, and 4) the availability of reference toxicity data for the same or similar species. The baseline ecological risk assessment focused on predicting effects to individual species; therefore, a food web analysis, which would be appropriate for evaluation of community effects, was not performed.

As indicated in Section 6.2.3.3, the Arctic ground squirrel is probably the most abundant terrestrial mammal at Kotzebue LRRS (Dau, J., 18 April 1995, personal communication). This animal serves as prey for many larger predators, such as foxes and wolves. Several other mammals found at Kotzebue LRRS stand out due to their importance as commercial or subsistence targets. For land mammals, both caribou and moose make up a large part of the subsistence diet (Fall and Utermohle 1993, Georgette and Loon 1993). Caribou are consumed more frequently than are moose, and are found more frequently in the vicinity of Kotzebue (Erlick, J., 17 January 1995, personal communication). This latter factor is an important consideration because these animals are more likely to be exposed to COPECs at the site. Among marine mammals, ringed seals and bearded seals are the most frequently hunted. Ringed seals are hunted more frequently than are bearded seals, and can be considered year-round residents in the Kotzebue vicinity. Bearded seals are typically found far offshore during the winter when landfast ice is present.

6.3 TOXICITY ASSESSMENT

This section describes the assessment and measurement endpoints to be used in the ecological risk assessment and the concentrations of COPECs that could be expected to result in the chosen endpoints.

6.3.1 Assessment and Measurement Endpoints

An endpoint is a characteristic of an ecological component (e.g., survival of an important species) that may be affected by exposure to a stressor (U.S. EPA 1992b). Two types of endpoints are commonly used in ecological risk assessments. Assessment endpoints are expressions of the actual environmental value that is to be protected (e.g., continued health of an important population of animals). Measurement endpoints are measurable responses to a stressor that, ideally, are related to the chosen endpoint (U.S. EPA 1992b). Measurement endpoints at the individual level (e.g., mortality, reproduction, and growth) can be used to predict effects on an assessment endpoint at the population level. The measurement endpoints may or may not be the same for each chemical. Ideally, the chosen measurement endpoint is specific to the chosen key receptor species; however, lack of species-specific toxicity data for many wildlife species often makes extrapolation necessary.

For the three key receptor species selected, the assessment endpoints are the continued existence of healthy, viable populations in the vicinity of Kotzebue. The measurement endpoints are manifested at the level of the individual. Specifically, the measurement endpoints do not involve any actual field measurements, but are drawn from available toxicity databases such as Health Effects Assessment Summary Tables (HEAST) and Registry of Toxic Effects of Chemical Substances (RTECS). The measurement endpoints represent sub-lethal, chronic effects on the population of interest. Because no field sampling specific to the ecological risk assessment was conducted (e.g., species abundance, COPEC concentration in tissue), the link between the assessment endpoint (population level) and the measurement endpoints (individual level) will be extrapolated.

The measurement endpoint for each COPEC represents the lowest published (RTECS or HEAST 1994) chronic dose, if available, associated with no adverse effects to the target mammal species. Toxicity values were obtained for 58 of the 67 COPECs [all except magnesium, endrin aldehyde, dibenzofuran, benzo(g,h,i)perylene, benzo(k)fluoranthene, and four different Arochlors]. Using the chronic no observed adverse effects level (NOAEL) represents a conservative approach, in that it can be assumed that doses below the NOAEL should not have any adverse effects on the individual whatsoever. If no NOAEL dose could be obtained, the lowest observed adverse effects level (LOAEL) was used instead. The dose lethal to 50 percent of the test population (LD50) was used if the LOAEL was not available. All doses other than NOAELs were extrapolated NOAEL-equivalents using uncertainty factors.

6.3.2 Uncertainty Factors Applied to Measurement Endpoints

Each of the measurement endpoints were derived from a laboratory experiment using a common laboratory mammal, such as a rat or a mouse. The dose of a toxic chemical known to adversely affect a rat or a mouse is likely to be different than the dose that is toxic to either of the key receptor species, ringed seal or caribou. Also, the dose that is responsible for lethality in the test species (e.g., LD50) is likely to be higher than the highest dose at which no adverse effects are observed (e.g., NOAEL).

Uncertainty factors (UF) are often applied to toxicity data in order to extrapolate to the test species of interest. This is particularly common in risk assessments. Two types of UFs can be applied. The first type of UF is used to account for inter-species differences in the response to a toxic chemical. The second type of UF is used to account for the differences in endpoints for the reported dose (e.g., lethal vs. non-lethal, chronic vs. acute).

The UF approach was applied to toxicity data for the baseline ecological risk assessment. The UFs used were based on those suggested by Calabrese and Baldwin (1993). For interspecies differences, a UF of 100 was used for most COPECs in the seal and caribou pathways, and a UF of 60 was used for most COPECs in the ground squirrel pathways. These values were suggested when extrapolating between two species in different orders within the same class (UF of 100) or two species in different families within the same order (UF of 60)(Calabrese and Baldwin 1993). Both ringed seal (order Pinnipedia) and caribou (order Artiodactyla) are in the same class (Mammalia) and the Arctic ground squirrel is in the same order (Rodentia) as the test species (e.g., rat or mouse) from which most of the toxicity data were obtained. UFs of the second variety are also from Calabrese and Baldwin (1993). They are listed below.

<u>Extrapolation</u>	<u>UF</u>
Acute to chronic	10
LOAEL to NOAEL	10
LD50 to LOAEL	50

UFs are applied by dividing them into the observed doses, thus yielding a dose that is more conservative than the original dose. For example, if the observed NOAEL dose for a mouse was 100 mg/kg/d, the dose for a caribou would $100/100 = 1$ mg/kg/d. A list of all the toxicity data used in this ecological risk assessment is provided in Table 6-2.

6.4 EXPOSURE ASSESSMENT

The exposure assessment describes how the expected dose (concentration/time) to which the key receptor species might be exposed was calculated, given the observed environmental concentrations of COPECs. The assessment was done separately for the marine environment, which included the Beach area, and the terrestrial environment, which included the East Drainage, West Drainage, and White Alice areas. A conceptual diagram of the ecological exposure pathways is provided in Figure 6-1. Additional details for each pathway are provided below.

Table 6-2. Extrapolated Oral Reference Doses of COPECs for Ringed Seal, Caribou, and Ground Squirrel
Kotzebue LRRS Ecological Baseline Risk Assessment (Page 1 of 2)

COPEC	Study Type	Study Duration	Tox. Oral Endpoint	Species	Original Dose (mg/kg-d)	Ref (oral)	Seal and Caribou ¹		Ground Squirrel ¹	
							Uncertainty Factor	Extrapolated Dose (mg/kg-d)	Uncertainty Factor	Extrapolated Dose (mg/kg-d)
Metals										
Antimony	LD50	chronic	unknown	rat	7000	RTECS	50000	0.14	30000	0.23
Barium	TDLo	chronic	vascular	rat	26622	RTECS	1000	26.62	600	44.37
Cadmium	TDLo	chronic	fertility	rat	21.5	RTECS	1000	0.02	600	0.04
Lead	TDLo	chronic	fertility	mouse	300	RTECS	1000	0.30	600	0.50
Magnesium	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Manganese	NOAEL	chronic	cns	man	0.14	HEAST	100	0.001	100	0.001
Mercury	TDLo	chronic	behavioral	man	43	RTECS	1000	0.04	1000	0.04
Selenium	TDLo	chronic	embryo	mouse	134	RTECS	1000	0.13	600	0.22
Silver	LD	chronic	unknown	guinea pig	5000	RTECS	50000	0.10	30000	0.17
Pesticides/PCBs										
4,4'-DDT	TDLo	chronic	behavioral	man	5	RTECS	1000	0.01	1000	0.01
alpha BHC	LD50	chronic	unknown	mouse	59	RTECS	50000	0.001	30000	0.002
alpha-Chlordane	LD50	chronic	unknown	mouse	125	RTECS	50000	0.003	30000	0.004
Arochlor 1016	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Arochlor 1221	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Arochlor 1232	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Arochlor 1242	TDLo	chronic	liver	rat	366	RTECS	1000	0.37	600	0.61
Arochlor 1248	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Arochlor 1254	n/a	chronic	fertility	mammal	14	RTECS	1000	0.01	600	0.02
Arochlor 1260	TDLo	chronic	fertility	mouse	74	RTECS	1000	0.07	600	0.12
delta BHC	LD50	chronic	unknown	mouse	59	RTECS	50000	0.001	30000	0.002
Dieldrin	NOAEL	chronic	liver	rat	3	HEAST	100	0.03	60	0.05
Diethyl Phthalate	NOAEL	chronic	unknown	rat	750	HEAST	100	7.50	60	12.50
Endosulfan Sulfate	LD50	chronic	unknown	rat	10	RTECS	50000	0.0002	30000	0.0003
Endrin	NOEL	chronic	unknown	dog	0.025	HEAST	100	0.0003	100	0.0003
Endrin Aldehyde	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
gamma-Chlordane	TDLo	chronic	liver	mouse	112	RTECS	1000	0.11	600	0.19
Heptachlor	NOEL	chronic	liver	rat	0.15	HEAST	100	0.002	60	0.003
Heptachlor Epoxide	LOAEL	chronic	liver	dog	0.0125	HEAST	1000	0.00001	1000	0.00001
Methoxychlor	NOEL	chronic	maternal	rabbit	5.01	HEAST	100	0.05	100	0.05
Toxaphene	TDLo	chronic	embryo	mouse	100	RTECS	1000	0.10	600	0.17
Semi-volatile Organics										
2,4-Dichlorophenol	TDLo	chronic	developmental	rat	20	RTECS	1000	0.02	600	0.03
2,4-Dinitrotoluene	NOAEL	chronic	unknown	dog	0.2	HEAST	100	0.0020	100	0.0020
2,6-Dinitrotoluene	NOAEL	chronic	unknown	dog	4	HEAST	100	0.04	100	0.04
2-Methylnaphthalene	LD50	chronic	unknown	rat	1630	RTECS	50000	0.03	30000	0.05
2-Nitroaniline	LD50	chronic	unknown	mouse	1070	RTECS	50000	0.02	30000	0.04
2-Nitrophenol	LD50	chronic	unknown	rat	334	RTECS	50000	0.01	30000	0.01
4-Methylphenol	NOAEL	chronic	gastro	rabbit	5	HEAST	100	0.05	100	0.05

Table 6-2. Extrapolated Oral Reference Doses of COPECs for Ringed Seal, Caribou, and Ground Squirrel
Kotzebue LRRS Ecological Baseline Risk Assessment (Page 2 of 2)

COPEC	Study Type	Study Duration	Tox. Oral Endpoint	Species	Original Dose (mg/kg-d)	Ref (oral)	Seal and Caribou ¹		Ground Squirrel ¹	
							Uncertainty Factor	Extrapolated Dose (mg/kg-d)	Uncertainty Factor	Extrapolated Dose (mg/kg-d)
4-Nitroaniline	TDL ₀	chronic	blood	rat	120	RTECS	1000	0.12	600	0.20
4-Nitrophenol	LD50	chronic	unknown	rat	250	RTECS	50000	0.01	30000	0.01
Acenaphthylene	LD50	chronic	unknown	rat	1700	RTECS	50000	0.03	30000	0.06
Anthracene	NOEL	chronic	liver	mouse	1000	HEAST	100	10.00	60	16.67
Benzo(b)fluoranthene	TDL ₀	chronic	gastro	mice	191.8	Superfund	1000	0.19	600	0.32
Benzo(g,h,i)perylene	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Benzo(k)fluoranthene	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Benzoic Acid	NOAEL	chronic	unknown	man	312	HEAST	100	3.12	100	3.12
Butylbenzylphthalate	NOAEL	chronic	liver	rat	159	HEAST	100	1.59	60	2.65
di-n-butyl Phthalate	NOAEL	chronic	embryo	rat	125	HEAST	100	1.25	60	2.08
Dibenz(a,h)anthracene	TDL ₀	chronic	tumor	mouse	4160	RTECS	1000	4.16	600	6.93
Dibenzofuran	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dimethylphthalate	NOEL	chronic	unknown	rat	1000	HEAST	100	10.00	60	16.67
Fluorene	NOAEL	chronic	unknown	mouse	125	HEAST	100	1.25	60	2.08
Hexachlorobutadiene	TDL ₀	chronic	newborn	rat	45	RTECS	1000	0.05	600	0.08
Hexachlorocyclopentadiene	LDL ₀	chronic	unknown	rabbit	420	RTECS	1000	0.42	1000	0.42
Isophorone	NOEL	chronic	unknown	dog	150	HEAST	100	1.50	100	1.50
Phenol	LDL ₀	chronic	respiration	man	10	RTECS	1000	0.01	100	0.10
Volatile Organics										
1,1,2-Trichloro-1,2,2-trifluoroethane	LD50	chronic	gastro	rat	43000	RTECS	50000	0.86	30000	1.43
1,1-Dichloroethene	TDL ₀	chronic	fertility	rat	200	RTECS	1000	0.20	600	0.33
2-Hexanone	LD50	chronic	unknown	guinea pig	914	RTECS	50000	0.02	30000	0.03
Acetone	NOEL	chronic	liver	rat	100	HEAST	100	1.00	60	1.67
Carbon Disulfide	TDL ₀	chronic	fertility	rabbit	350	RTECS	1000	0.35	1000	0.35
Chloroform	TDL ₀	chronic	liver	rat	5	RTECS	1000	0.01	600	0.01
cis-1,2-Dichloroethylene	NOAEL	chronic	blood	rat	32	HEAST	100	0.32	60	0.53
Ethylbenzene	LD50	chronic	liver	rat	3500	RTECS	50000	0.07	30000	0.12
Methyl Ethyl Ketone (2-butanone)	NOAEL	chronic	fetus	rat	1711	HEAST	100	17.11	60	28.52
Methylene Chloride	NOAEL	chronic	liver	rat	5.85	HEAST	100	0.06	60	0.10
Toluene	NOAEL	chronic	liver	rat	223	HEAST	100	2.23	60	3.72
Xylenes, total	TDL ₀	chronic	embryo	mouse	20.6	RTECS	1000	0.02	600	0.03

¹ Different uncertainty factors applied to seal/caribou vs. ground squirrel due to interspecies variation (see text for explanation)

NOAEL or NOEL = Dose at which no adverse effects are observed

LOAEL or TDL₀ or LDL₀ = lowest dose at which adverse effects are observed

LD50 = dose which is lethal to 50 percent of the test population

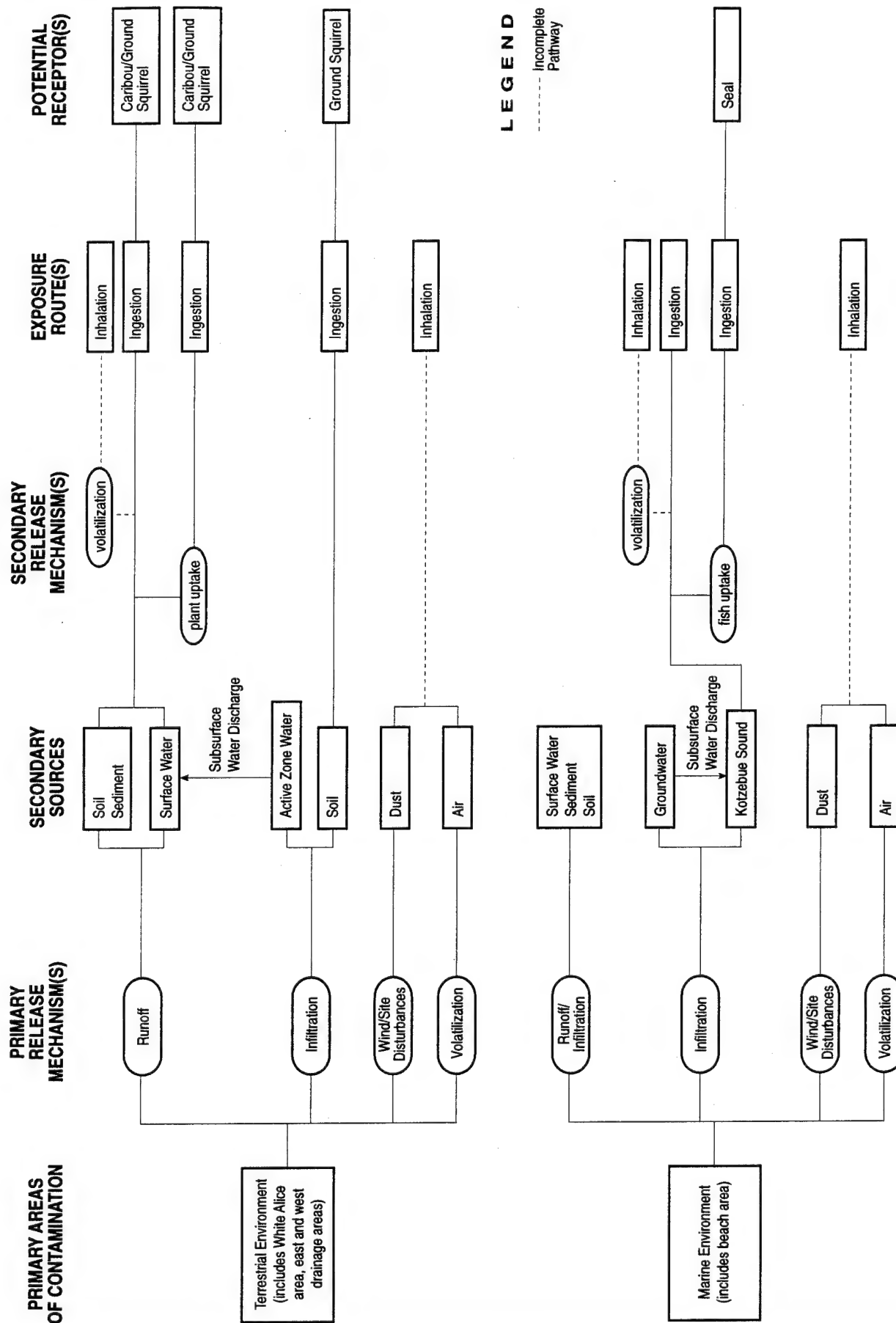


Figure 6-1. Ecological Exposure Pathways Evaluated for Kotzebue LRRS, Alaska.

6.4.1 Marine Environment

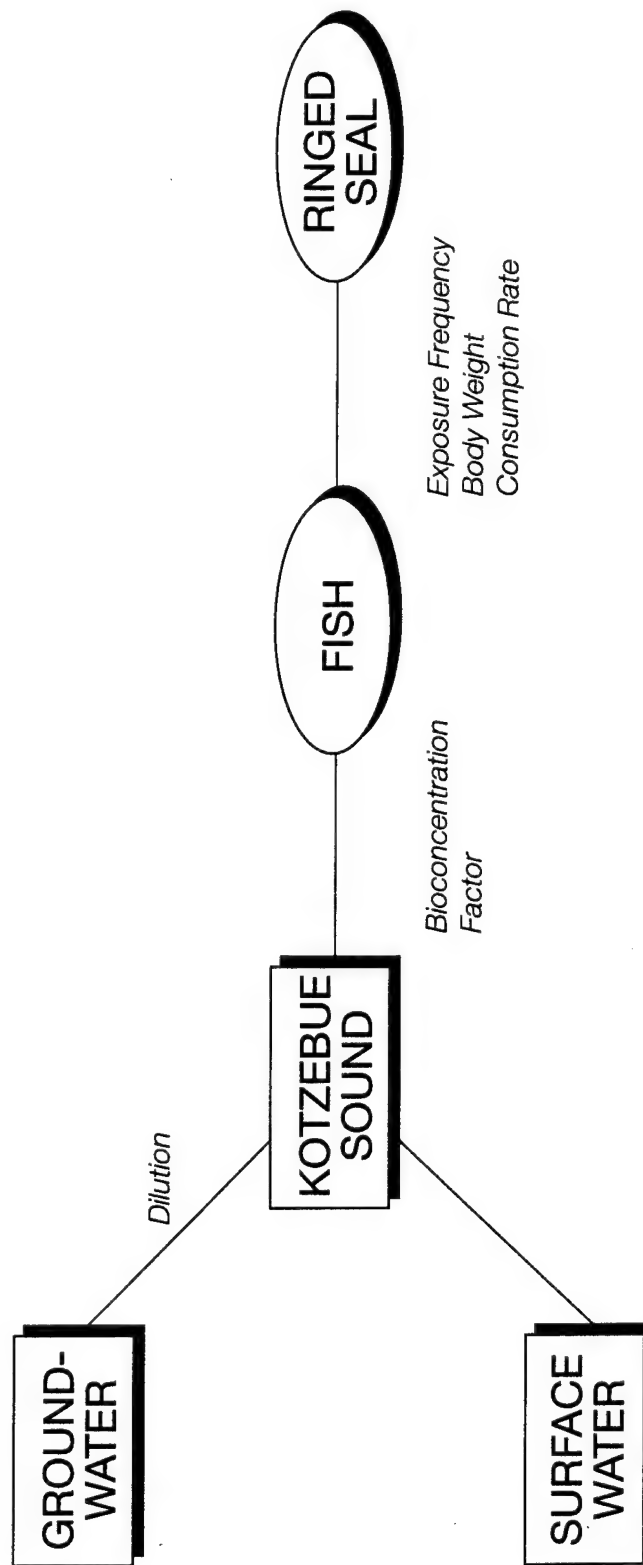
The receptor species evaluated in the marine environment was the ringed seal. The exposure assessment for ringed seals involved the dietary exposure pathway, which is the only significant route of exposure (Figure 6-1). Two other potential routes of exposure, ingestion of water and dermal contact, were considered to be insignificant. Ringed seals, like other mammals, can not drink seawater without becoming ill; therefore, the ingestion of water pathway is of no significance. The dermal contact pathway is difficult to quantitate because of the unavailability of seal skin permeability factors and the absence of toxicity data specific to dermal uptake. However, given the thick skin and heavy layer of blubber typical of seals, it is likely that this exposure pathway is of very little significance.

The first step in characterizing the dietary route of exposure was to estimate the concentrations of COPECs in the diet of ringed seals. The dietary exposure pathway depicted in Figure 6-2 assumed that the diet of ringed seals is made up entirely of fish. While this is a conservative approach when applied over the entire year, their diet is almost entirely fish during the winter (Burns et al. 1985). Figure 6-2 identifies the variables that were required to calculate the COPEC dose to which the seals were potentially exposed. Bioconcentration factors (BCFs) were retrieved from the literature and the Hazardous Substance Database (HSDB), or were estimated based on the octanol-water partition coefficient (K_{ow}). Chemical-specific BCFs for fish were used to estimate the chemical concentration to be expected in fish tissue for a given concentration in water using the following equation:

$$BCF = \frac{C_{fish}}{C_{water}} \quad \text{(Equation 6-1)}$$

where C_{fish} is the concentration in fish in $\mu\text{g/kg}$ and C_{water} is the concentration in water in $\mu\text{g/L}$.

The entire suite of COPECs were not analyzed in surface waters from Kotzebue Sound (only volatile and semivolatile organic compounds were measured in surface water). However, all COPECs were analyzed in groundwater samples collected at two locations within the beach site. To estimate surface water concentrations, a near-field dilution value for groundwater was calculated using a simple compartment model. The model assumed that a volume of groundwater seeps into Kotzebue Sound through the beach. The groundwater is diluted by a volume of seawater that sweeps across the beach. Using a model which



NOTE: VARIABLES IN ITALICS
ARE ESTIMATED AS
PART OF EXPOSURE
ASSESSMENT

Figure 6-2. Simplified Exposure Pathway for the Marine Investigative Areas, Ecological Risk Assessment, Kotzebue LRRS, Alaska.

estimated the volume flux of groundwater and seawater in the beach area and the magnitude of tidal and wind-induced currents, a dilution value of 2,000,000 was estimated. The derivation of this value is described in greater detail in Appendix D.

The use of near-field dilution represents a conservative approach. Near-field dilution of groundwater occurs immediately adjacent to the beach. Far-field dilution occurs throughout Kotzebue Sound. The key receptor species are likely to be found both inside and outside the area considered to be near-field. The overall dilution of groundwater into Kotzebue Sound, including both near-field and far-field components, is likely to be greater than 2,000,000. As a rough estimate of the potential far-field dilution, the volume of Kotzebue Sound that is mixed daily through tides was calculated to be $1.6 \times 10^9 \text{ m}^3$. Using the groundwater flux volume calculated for the near-field dilution (see Appendix D), there is a potential for an additional 100-fold dilution due to far-field effects. For each COPEC, the chemical concentrations in water used to estimate fish tissue concentration was the EPC (Appendix Table B-4) divided by the near-field dilution value.

The final step in characterizing exposure is to estimate the daily COPEC dose to the ringed seal. The following dose equation, taken from U.S. EPA (1993b), was used:

$$ADD_{pot} = C_{fish} \times EF \times NIR_{fish} \quad (\text{Equation 6-2})$$

where ADD_{pot} is the potential average daily dose in mg/kg-day, EF is the exposure frequency, and NIR_{fish} is the ingestion rate normalized to body weight in kg/kg-day. The EF factor can be described in two ways. It can be thought of as the proportion of the animal's life potentially spent in contact with the COPEC at the Kotzebue LRRS. Alternatively, it can be thought of as the fraction of food consumed that is contaminated. If the animal spent its entire life in the vicinity of the Kotzebue LRRS, all of its prey would be potentially contaminated, thus EF would be equal to 1. Ringed seals are potentially found in the area year-round (Erlick, J., 17 January 1995, personal communication), thus EF was set conservatively equal to 1.

The calculation of normalized ingestion rate (NIR_{fish}) requires estimates of both body weight (kg) and ingestion rate (kg/d). For ringed seals, both of these values are available from the literature. Using a

body weight of 50 kg (Frost et al. 1985) and an ingestion rate of 2 kg/d (Lowry et al. 1980), the NIR_{fish} was calculated as 0.04 kg/kg-d.

6.4.2 Terrestrial Environment

The two receptor species evaluated in the terrestrial environment were the Arctic ground squirrel and the caribou. The exposure assessment for the terrestrial environment included those pathways presented in the simplified exposure pathway (Figure 6-3). All of the pathways considered are oral routes. The dietary and water intake pathways were considered for both caribou and ground squirrels. A third type of oral route, ingestion of soil, was considered only for ground squirrels. This pathway was not considered to be significant for caribou because these animals are browsers and do not typically include any soil in their diet (Boertje 1990, Crête et al. 1990). Two other exposure routes, dermal and inhalation, were also not considered to be significant. Dermal exposures to terrestrial animals are typically only considered if the animal swims or burrows (U.S. EPA 1993b). Caribou are not known to browse on aquatic plants, thus they would not be likely to spend a significant portion of time in contact with potentially contaminated water (Erlick, J., 17 January 1995, personal communication). Ground squirrels do burrow, but their thick fur minimizes dermal exposure. Also, toxicity data for dermal exposure is unavailable for most of the COPECs. The inhalation exposure route is difficult to quantitate because of the unavailability of respiratory physiology data for caribou and ground squirrels and the absence of toxicity data specific to inhalation uptake. However, given the large size of the Kotzebue area relative to the area potentially contaminated with volatile organics (USAF 1995a), it is unlikely that this exposure pathway is of great significance.

6.4.2.1 Dietary Exposure Route. The first step in characterizing the dietary route of exposure was to estimate the concentrations of COPECs in the diet of caribou and ground squirrels. The dietary exposure pathway depicted in Figure 6-2 assumed that the diet of each animal is made up entirely of plants. The diet of caribou is relatively diverse and can include items such as deciduous and evergreen shrubs, lichens, mosses, mushrooms, and berries (Boertje 1990, Crête et al. 1990). The diet of ground squirrels consists primarily of dicotyledons (flowering plants), including a wide variety of herbs and shrubs (Sage 1986). Soil contaminant uptake data specific to each of these food types typically consumed by these animals are not available. As a conservative approach, this exposure assessment assumed that all of the diet for both animals consisted of a generic plant. Not all chemicals would be expected to be taken up by plants. Compounds with a soil/water partition coefficient (K_d) of greater than 1,000 are generally

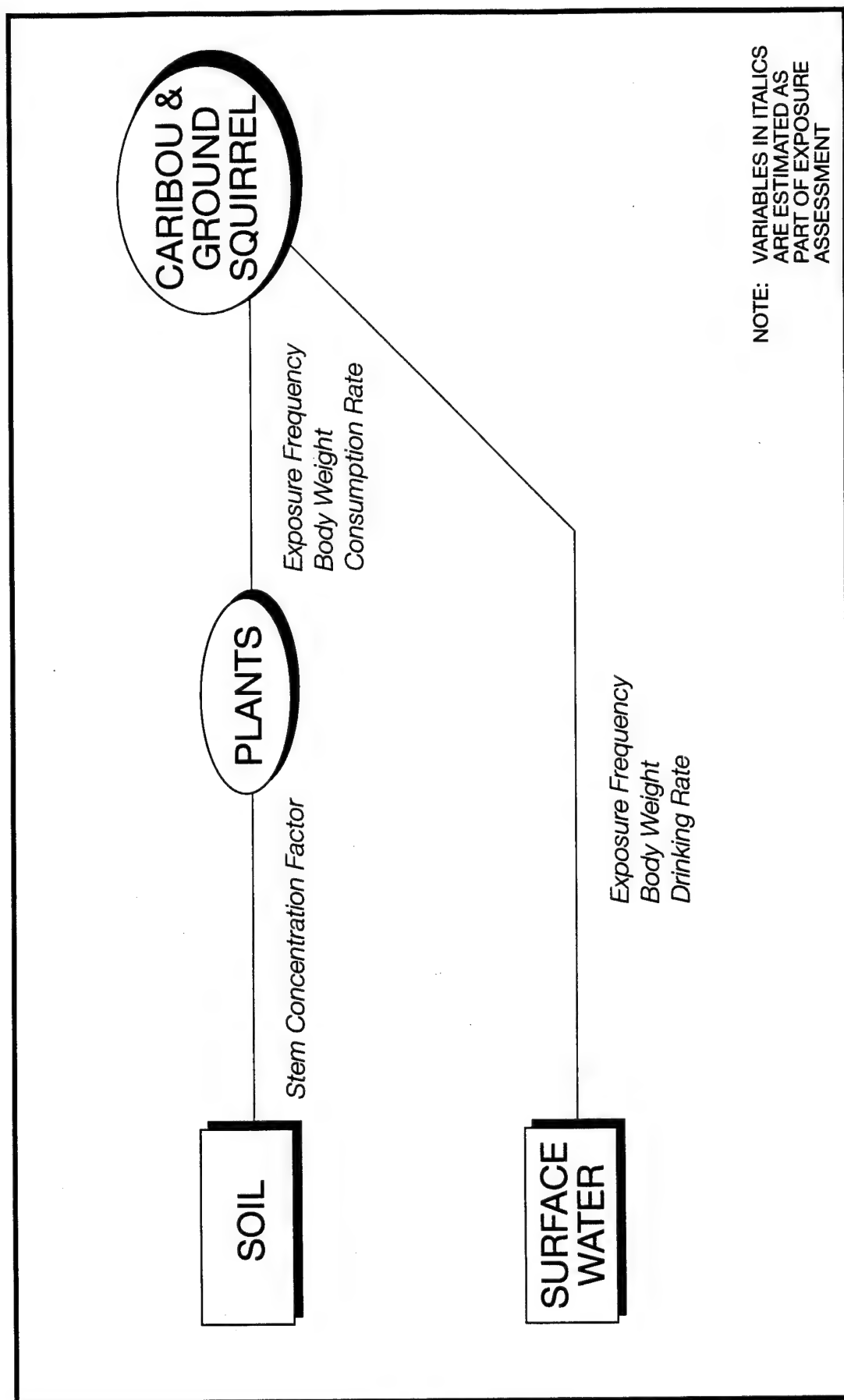


Figure 6-3. Simplified Exposure Pathway for the Terrestrial Investigative Areas, Ecological Risk Assessment, Kotzebue LRRS, Alaska.

thought to be unavailable for plant uptake by soil sorption (Wang and Jones 1994). K_d can be estimated by $K_{oc} \times f_{oc}$, where K_{oc} is the organic carbon partition coefficient and f_{oc} is the fraction of organic carbon. Several COPECs had K_d values greater than 1,000 [benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chlordane and isomers, chrysene, DDT and isomers, fluoranthene, and pyrene], indicating that they do not pose any risk from the dietary route of exposure. These compounds were excluded from any further exposure assessment via the dietary exposure route.

The calculation of the COPEC concentration to be expected in plants used the following equation:

$$SCF = \frac{C_{stem}}{C_{soil}} = \left[\frac{\delta}{(\delta K_{ow} f_{oc} + \theta)} \right] \left[10^{(0.951 \log K_{ow} - 2.05)} + 0.82 \right] \{ 0.784 \exp -[(\log K_{ow} - 1.78)^2 / 2.44] \}$$

(Equation 6-3)

where SCF equals the stem concentration factor (unitless), C_{stem} is the COPEC concentration in the stem of the plant ($\mu\text{g/kg}$), C_{soil} is the COPEC EPC in the soil ($\mu\text{g/kg}$), δ is the soil bulk density (g/cm^3), and θ is the soil-water content by volume (ml/cm^3) (Wang and Jones 1994, Briggs et al. 1982, 1983). Chemical-specific K_{ow} values were retrieved primarily from U.S. EPA (1989c). Values for f_{oc} , δ , and θ were calculated from samples taken from tundra and fill locations at Kotzebue LRRS during the 1994 RI (USAF 1995a). The values used in Equation 6-3 for these three parameters were 0.0398, 1.89 g/cm^3 , and 0.336 ml/cm^3 , respectively. For each COPEC, C_{stem} was calculated by rearranging Equation 6-3 and using the maximum C_{soil} value for each investigative area.

The final step in characterizing exposure via the dietary route is to estimate the daily COPEC dose to the caribou and ground squirrel. The following dose equation, modified from U.S. EPA (1993b), was used:

$$ADD_{pot} = C_{stem} \times EF \times NIR_{plant}$$

(Equation 6-4)

where ADD_{pot} is the potential average daily dose in mg/kg-day , EF is the exposure frequency, and NIR_{plant} is the ingestion rate normalized to body weight in kg/kg-day . Caribou have used Baldwin Peninsula each of the last three years as part of their migration pathway to and from their calving grounds

north of the Noatak River and their winter area south of the Kobuk River (Erlick, J., 17 January 1995, personal communication). As a conservative estimate, it was assumed that the caribou herd spent one week on Baldwin Peninsula during both the northward and southward legs of their migration. Thus, the value chosen for EF was 1/26 (2 weeks/52 weeks). The months the caribou are most likely to be present on the site are April (northward migration) and September (southward migration)(Georgette and Loon 1993). During both of these months, the contaminants in soil and water are likely to be more available to caribou than during the winter months when the ground is frozen. Ground squirrels are present at the site year-round, but during hibernation, they do not eat. These animals hibernate for approximately 220 days/year (Galster and Morrison 1976), thus the EF value was 145/365.

The calculation of normalized ingestion rate (NIR_{plant}) requires estimates of both body weight (kg) and ingestion rate (kg/d). For caribou, using a body weight of 85 kg (Adamczewski et al. 1993) and an ingestion rate of 3.55 kg/d (Suter 1993), the NIR_{plant} was calculated as 0.042 kg/kg-d. For ground squirrels, using a body weight of 500 g (Galster and Morrison 1976) and an ingestion rate of 20.67 g/day (Nagy 1987), the NIR_{plant} was calculated as 0.0413 kg/kg-d.

6.4.2.2 Water Intake Exposure Route. The second exposure route considered for caribou and ground squirrel was the intake of water (i.e., drinking). The equation for ADD_{pot} from drinking water was the following:

$$ADD_{pot} = C_{water} \times EF \times NIR_{water} \quad \text{(Equation 6-5)}$$

where C_{water} and NIR_{water} are the COPEC EPC in surface water ($\mu\text{g/L}$) and the normalized ingestion rate in kg/kg-day, respectively. EF values identical to those used for Equation 6-4 (1/26 and 145/365) were used for this exposure route. For caribou, using a body weight of 85 kg (Adamczewski et al. 1993) and a water ingestion rate of 18.97 kg/d (Suter 1993), NIR_{water} was calculated to be 0.223 kg/kg-d. For ground squirrel, using a body weight of 500 g (Galster and Morrison 1976) and a water ingestion rate of 0.0531 L/day (U.S. EPA 1992b), NIR_{water} was calculated to be 0.106 kg/kg-d.

6.4.2.3 Soil Ingestion Exposure Route. This exposure route was considered only for ground squirrels. The equation for ADD_{pot} from soil ingestion was the following:

$$ADD_{pot} = C_{soil} \times EF \times NIR_{soil} \quad (\text{Equation 6-6})$$

where C_{soil} and NIR_{soil} are the COPEC EPC in soil (mg/kg) and the normalized ingestion rate in kg/kg-day, respectively. An EF value identical to that used for Equation 6-4 (145/365) was used for this exposure route. The percentage of soil in the ground squirrel was conservatively estimated as 10%, based on Beyer et al. (1992), who calculated soil ingestion rates for small mammals as 2-7.7%. Using the 10% value, in conjunction with a food ingestion rate of 20.67 g/day and a body weight of 500 g, the NIR_{soil} was calculated to be 0.0041 kg/kg-d.

6.5 RISK CHARACTERIZATION

Ecological risks for the Kotzebue LRRS were characterized by the quotient method, which is the most commonly used model for risk estimation (Suter 1993). In this simple one-dimensional scale model, risk is assumed to increase with the magnitude of the quotient according to the following equation:

$$HQ = \frac{ADD_{pot}}{Rfd / UF} \quad (\text{Equation 6-7})$$

where HQ is the hazard quotient, ADD_{pot} is the potential exposure dose, and RfD and UF are the reference toxicity doses and uncertainty factors, respectively. For HQs of less than 1, an assumption is made that the estimated risk from that particular combination of COPEC, location, species, and exposure route is not significant. For HQs greater than 1, there is an indication that the estimated risk could be significant. The quotient method yields information about the potential for adverse effects to a single organism. The results of this method are not intended to be used nor should they be extrapolated to higher levels of biological organization, such as populations or ecosystems.

The uncertainty associated with the calculated HQs was relatively high, because several factors had to be extrapolated. Any HQ value greater than 1, while representing a cause for concern, should not be construed as a *de facto* statement of impending ecological decline. Instead, HQ values greater than 1 should help to establish where additional evaluation may be warranted.

The estimated ecological risks for both the aquatic and terrestrial environments are characterized below. For COPECs which have HQs greater than 1 for any of the areas, a site map is included with the locations of each sample concentration which exceeded the threshold concentration that would result in a HQ of 1. This map provides information on the distribution of the contaminants of special concern, thus making it possible to delineate areas which could require remediation based solely on the results of the ecological risk assessment. The risk estimates for each COPEC in each pathway are presented by site in Appendix H.

6.5.1 Aquatic Environment

The only pathway evaluated for Kotzebue Sound was the dietary pathway for ringed seals. None of the 33 COPECs in groundwater in the Beach area had HQ values greater than 0.001 (Table 6-3 and Appendix Table H-1). The total risk for all detected COPECs was 2.08E-4. Given the conservative assumptions made for this exposure route, it is very unlikely that the contaminants detected at Kotzebue LRRS have or will adversely affect ringed seals. These results are in contrast to a preliminary risk assessment performed in 1988, which identified TPH at the Beach Tank site as a potentially significant risk to aquatic organisms (USAF 1990a).

6.5.2 Terrestrial Environment

A total of three pathways were evaluated in the terrestrial environment. The dietary and water intake routes were evaluated for both ground squirrels and caribou, and the soil ingestion exposure route was evaluated for ground squirrel. The soil pathways (dietary and soil ingestion) were evaluated separately for each of the four investigative areas. The water intake pathway was evaluated for the White Alice, East Drainage, and West Drainage Areas. Surface water samples were not collected in the Beach area from areas likely to represent a possible route of exposure to the key receptor species.

6.5.2.1 Dietary Exposure Route. The estimated ecological risks to caribou and ground squirrels from the dietary pathway are presented in Tables 6-4 and 6-5, respectively. For caribou, total xylenes in the

TABLE 6-3. ESTIMATED RISK TO RINGED SEAL FROM THE DIETARY EXPOSURE ROUTE
KOTZEBUE LRRS, ALASKA

Detected COPECs ¹	Hazard Quotient Beach Site
4,4'-DDT	1.60E-04
Xylenes, total	3.30E-05
2-Methylnaphthalene	9.56E-06
Manganese	4.27E-06
Acenaphthylene	6.51E-07
Total for Detected COPECs	2.08E-04
Total for Non-detected COPECs	6.00E-04
¹ Only the five COPECs showing the largest HQ are shown	

**TABLE 6-4. ESTIMATED RISK TO CARIBOU FROM THE DIETARY EXPOSURE ROUTE
KOTZEBUE LRRS, ALASKA**

Detected COPECs ¹	Hazard Quotient			
	White Alice Site	Beach Site	East Drainage Site	West Drainage Site
Xylenes, total	0.00025	0.446	0.463	3.64
2-Methylnaphthalene	0.0247	0.395	0.364	0.517
4-Nitrophenol	ns	ns	0.422	0.321
4-Methylphenol	0.0193	ns	0.00804	0.0113
2-Nitroaniline	ns	ns	0.0712	ns
2-Nitrophenol	ns	ns	ns	0.124
Phenol	0.0189	ns	0.362	0.0095
Methylene Chloride	0.00342	0.0049	0.0034	0.0059
Acetone	0.00061	0.00073	0.00044	0.00095
Total for Detected COPECs	0.0674	0.846	1.70	4.68
Total for Non-detected COPECs	0.00189	0.00113	0.00211	0.00470
ns = not significant; chemical was not a COPEC for this site				
¹ Only the COPECs showing the largest HQ are shown				

**TABLE 6-5. ESTIMATED RISK TO GROUND SQUIRRELS FROM THE DIETARY EXPOSURE ROUTE
KOTZEBUE LRRS, ALASKA**

Detected COPECs ¹	Hazard Quotient			
	White Alice Site	Beach Site	East Drainage Site	West Drainage Site
Xylenes, total	0.00156	2.73	2.83	22.3
2-Methylnaphthalene	0.151	2.42	2.23	3.17
4-Nitrophenol	ns	ns	2.58	1.97
4-Methylphenol	0.197	ns	0.0820	0.115
2-Nitroaniline	ns	ns	0.4360	ns
2-Nitrophenol	ns	ns	ns	0.757
Phenol	0.0193	ns	0.369	0.00966
Methylene Chloride	0.0209	0.0300	0.0208	0.0364
Acetone	0.00375	0.00445	0.00271	0.00584
Total for Detected COPECs	0.395	5.18	8.62	28.68
Total for Non-detected COPECs	0.0116	0.00689	0.0129	0.0288
ns = not significant; chemical was not a COPEC for this site				
¹ Only the COPECs showing the largest HQ are shown				

West Drainage area represented the largest risk from a single COPEC (HQ=3.64). The total risk from detected COPECs at this site was 4.68, which was approximately 1,000 times higher than the total risk from non-detected COPECs (Table 6-4). Two other COPECs (2-methylnaphthalene and 4-nitrophenol) had HQ values higher than 0.3 at both the East and West Drainage areas. For ground squirrels, the same three chemicals (xylenes, 2-methylnaphthalene, and 4-nitrophenol) represented the largest risk at the Beach, East, and West areas. The highest HQ value (22.3) was for total xylenes at the West Drainage area. All three chemicals had HQ values higher than 1 at both the East and West drainage areas (Table 6-5). The total risk to both caribou and ground squirrel from this pathway was greatest at the West Drainage area, followed by the East Drainage, Beach, and White Alice areas, in that order.

6.5.2.2 Water Intake Exposure Route. For the drinking water exposure route, none of the 14 detected COPECs or 16 non-detected COPECs had HQ values higher than 1 (Tables 6-6 and 6-7). The highest HQ values for both caribou and ground squirrel were for manganese at the East Drainage area and heptachlor epoxide at the West Drainage area. The total risk was highest at the East Drainage area and lowest at the White Alice area. The total risk for detected COPECs was 2-400 times higher than the total risk from non-detected COPECs (Tables 6-6 and 6-7).

6.5.2.3 Soil Ingestion Exposure Route. The soil ingestion exposure route for ground squirrels was relatively insignificant relative to the other pathways evaluated (Table 6-8). The largest risk estimate for a single COPEC was 0.0075 for total xylenes in the West Drainage area. The total risk was highest at the West Drainage area, followed by the East, Beach, and White Alice areas, in that order. The total risk from detected COPECs was 10-50 times greater than the total risk from non-detected COPECs.

6.5.3 Summary of Risk Estimates

The only exposure pathway for which the estimated total HQ value was greater than 1 was the dietary pathway for both caribou and ground squirrels. Based on the results from the evaluation of the dietary exposure route, the ground squirrel is a more sensitive ecological receptor at Kotzebue LRRS than the caribou. No significant risk to ecological receptors was indicated for dietary exposure route for ringed seals, water ingestion for caribou or ground squirrels, or soil ingestion for ground squirrels.

A total of 48 detected COPECs were evaluated in this baseline ecological risk assessment. Of this total, three chemicals (total xylenes, 2-methylnaphthalene, and 4-nitrophenol) were detected at concentrations

TABLE 6-6. ESTIMATED RISK TO CARIBOU FROM THE WATER INTAKE EXPOSURE ROUTE
KOTZEBUE LRRS, ALASKA

Detected COPECs ¹	Hazard Quotient		
	White Alice Site	East Drainage Site	West Drainage Site
Manganese	ns	0.184	ns
Heptachlor Epoxide	0.0137	0.0823	0.170
delta BHC	0.00278	3.63E-05	3.63E-05
Methylene Chloride	4.40E-04	ns	ns
Acetone	6.00E-05	ns	1.80E-04
Barium	ns	1.61E-05	ns
alpha BHC	ns	ns	7.23E-04
Heptachlor	ns	ns	2.86E-04
4,4'-DDT	ns	ns	1.28E-04
Total for Detected COPECs	0.017	0.27	0.171
Total for Non-detected COPECs	0.00782	0.00982	0.00048

ns = not significant; chemical was not a COPEC for this site
¹ Only the COPECs showing the largest HQ are shown

TABLE 6-7. ESTIMATED RISK TO GROUND SQUIRRELS FROM THE WATER INTAKE EXPOSURE ROUTE
KOTZEBUE LRRS, ALASKA

Detected COPECs ¹	Hazard Quotient		
	White Alice Site	East Drainage Site	West Drainage Site
Manganese	ns	0.903	ns
Heptachlor Epoxide	0.0674	0.405	0.834
delta BHC	0.00819	1.07E-04	1.07E-04
Methylene Chloride	0.0013	ns	ns
Acetone	1.77E-04	ns	5.29E-04
Barium	ns	4.75E-05	ns
alpha BHC	ns	ns	2.13E-03
Heptachlor	ns	ns	8.43E-04
4,4'-DDT	ns	ns	6.30E-04
Total for Detected COPECs	0.077	1.31	0.838
Total for Non-detected COPECs	0.0237	0.0296	0.00209

ns = not significant; chemical was not a COPEC for this site
¹ Only the COPECs showing the largest HQ are shown

TABLE 6-8. ESTIMATED RISK TO GROUND SQUIRRELS FROM THE SOIL INGESTION EXPOSURE ROUTE
KOTZEBUE LRRS, ALASKA

Detected COPECs ¹	Hazard Quotient			
	White Alice Site	Beach Site	East Drainage Site	West Drainage Site
4-Nitrophenol	ns	ns	2.21E-03	1.68E-03
Endrin	9.76E-04	8.74E-05	6.40E-05	2.89E-04
Xylenes, total	5.24E-07	9.18E-04	9.53E-04	7.50E-03
Antimony	1.35E-04	ns	ns	ns
Lead	1.35E-04	2.79E-04	2.39E-04	9.05E-05
4-Methyphenol	1.08E-04	ns	4.50E-05	6.30E-05
2-Methylnaphthalene	8.28E-05	1.33E-03	1.22E-03	1.74E-03
Methylene Chloride	7.60E-06	1.09E-05	7.54E-06	1.32E-05
Total for Detected COPECs	1.54E-03	2.63E-03	5.20E-03	1.23E-02
Total for Non-detected COPECs	1.50E-04	1.30E-04	2.80E-04	2.20E-04
ns = not significant; chemical was not a COPEC for this site				
¹ Only the COPECs showing the largest HQ are shown				

for which potentially significant risk ($HQ > 1$) to caribou or ground squirrels was indicated for the dietary pathway. The specific locations of samples for which the detected concentrations of total xylenes, 2-methylnaphthalene, and 4-nitrophenol in soil exceeded an estimated HQ of 1 for ground squirrels in the dietary exposure route are shown in Figure 6-3. The threshold values for estimated HQs of 1 were 2.6 mg/kg for total xylenes, 6.6 mg/kg for 2-methylnaphthalene, and 1.6 mg/kg for 4-nitrophenol.

For xylenes, 11 of the 73 soil samples which were collected exceeded an estimated HQ of 1. Six of the eleven samples were collected adjacent to AOC5-Small Day Tanks. One sample was collected from Site SS13 (AOC1-Landfarm) and two samples were collected near Site SS12-Spills No. 2 and 3. The final two xylene exceedances were collected from a single borehole (ST05-SB14) near one of the beach tanks at Site ST05-Beach Tanks (Figure 6-4).

For 2-methylnaphthalene, 15 of the 73 soil samples exceeded an estimated HQ of 1. The distribution pattern for these samples was similar to that of xylene. All but two samples collected from Site ST05 (Beach tanks) were from the main complex of buildings (Figure 6-3). A single soil sample collected from Site SS15 (AOC4) and analyzed for 4-nitrophenol exceeded an HQ of 1 (Figure 6-4).

6.6 UNCERTAINTY ANALYSIS

The risk estimates provided in Section 6.5 are based upon a number of assumptions which can not be disproved in the absence of site-specific data. Nonetheless, a qualitative assessment of the uncertainty of these estimates can be made. This section discusses the primary areas of uncertainty for each of exposure pathways examined.

6.6.1 Aquatic Environment

The most important areas of uncertainty surrounding the HQs estimated for ringed seals from the dietary pathway include 1) the exposure frequency, 2) the dilution of groundwater, and 3) the toxicity data. Probably the most conservative exposure assumption that was made concerns the exposure frequency (EF). An EF of 1 was used for the dietary pathway, which implies that all of the food consumed by the seals was contaminated to an equal degree. This value was chosen because these seals may be found in the Kotzebue vicinity year-round. However, it is likely that an individual seal obtains a significant

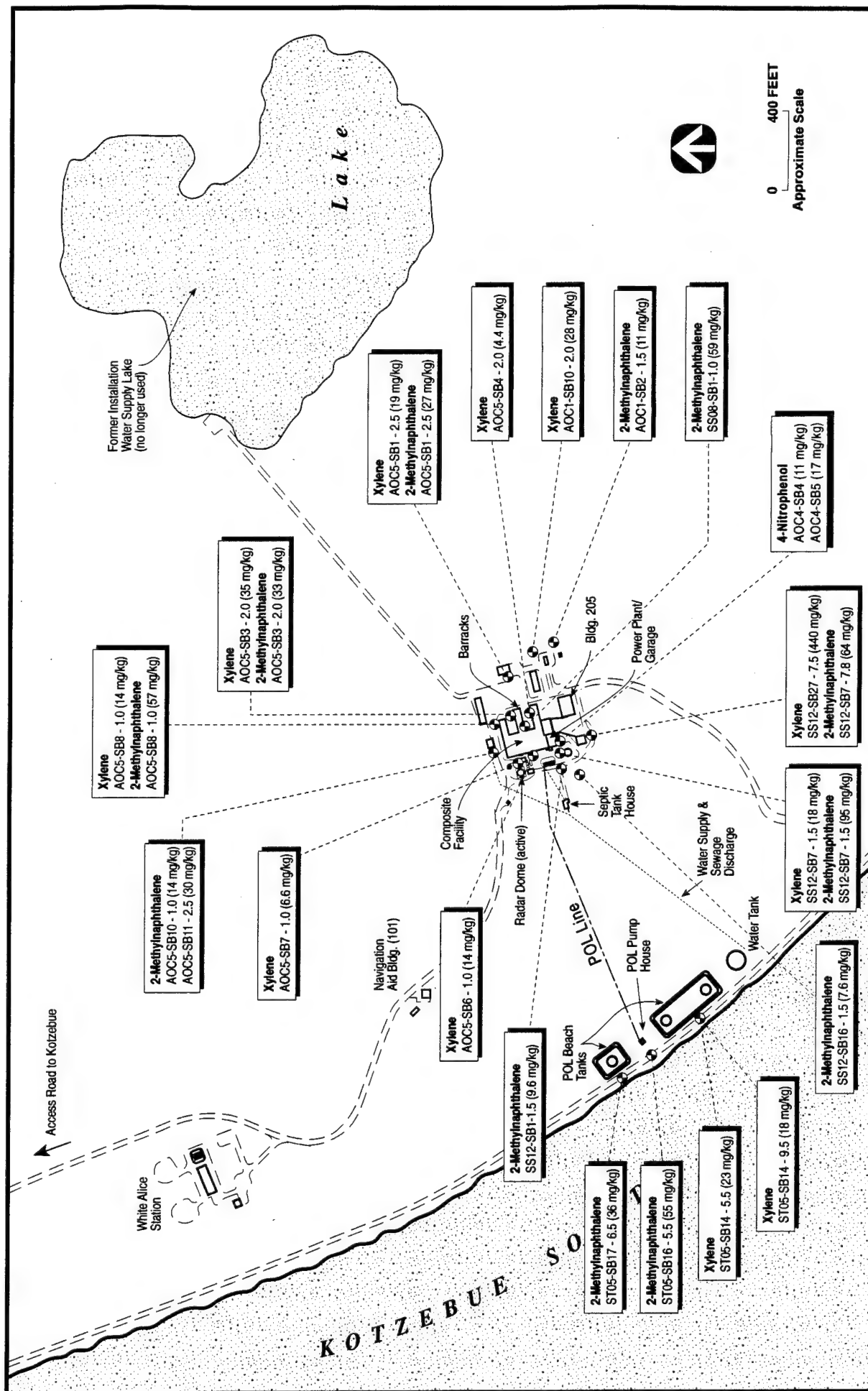


Figure 6-4. Locations of Samples For Which Concentrations of Xylenes, 2-Methylnaphthalene, and 4-Nitrophenol in Soil Exceeded Hazard Quotient of One for Ground Squirrels in Dietary Pathway, Kotzebue LRRS, Alaska.

portion of its food from areas that are outside the influence of contaminated groundwater at Kotzebue LRRS.

The use of groundwater data also represents considerable uncertainty. It can be assumed that groundwater is diluted once it seeps above ground in Kotzebue Sound. The dilution estimate provided in Appendix D is based on volumetric estimates of groundwater and ocean water flux. The estimate of ocean water flux is the more uncertain of the two flux estimates since it is based in part on the geometric shape of Kotzebue Sound as determined from navigational charts and not on empirical data collected in the field.

An additional area of uncertainty, the derivation of a reference toxicity dose, was addressed by the use of uncertainty factors. These were conservative extrapolations from toxicity data for laboratory mammals, not ringed seals.

6.6.2 Terrestrial Environment

The most important areas of uncertainty regarding the HQs estimated for caribou and ground squirrels from the drinking water and dietary exposure pathways and for ground squirrels from the soil ingestion pathway include: 1) exposure frequency, 2) exposure point concentrations, 3) contaminant uptake into plants, 4) soil ingestion rates, and 5) the toxicity data. The exposure assessments made for caribou assumed that a given animal would be present in the vicinity of Kotzebue LRRS for 2 weeks every year. This is a very conservative assumption considering the fact that the animals that have been sighted in the Kotzebue vicinity during recent years have been migrating and would be likely to remain within the influence of contaminants detected at Kotzebue LRRS for only short periods of time. The Kotzebue field biologist (Alaska Dept. of Fish and Game) estimated that an individual animal might only be present at the site for one-half day per year and that only 1 percent of the herd might be present at the site at all (Dau, J., 18 April 1995, personal communication). If it was assumed that an individual animal spent no more than 4 days/year [2 weeks (i.e., the original exposure frequency)/maximum estimated HQ for xylenes (3.6)] feeding in the vicinity of Kotzebue LRRS, the estimated HQs for xylenes would be less than 1. The exposure frequency for ground squirrel (145 days/year) assumed that an animal would be potentially exposed to COPECs during the entire time it was not hibernating. This is a reasonable assumption considering the fact that ground squirrels have many burrows at Kotzebue LRRS and would

not be expected to eat or drink during the 220-day hibernation. Thus, the exposure frequency estimate for ground squirrel is much less uncertain than the estimate for caribou.

Exposure point concentrations in the four media sampled were based on the 95% UCL of the mean (except in cases where the 95% UCL exceeded the maximum, in which case the maximum concentration was used) with half of the PQL used for samples in which the chemical was not detected. The use of the UCL and PQL takes into account the number of samples and the variability in the detected values. Therefore, the exposure estimates are based on reasonable maximum exposure concentrations.

Another area of uncertainty concerns the dietary pathway. The dietary exposure assessment for caribou and ground squirrel estimated the COPEC concentrations in a hypothetical plant. Whether this hypothetical plant bears any similarity to actual vegetation consumed by these animals is very difficult to determine. The distribution of potential browse for caribou and ground squirrels in the vicinity of Kotzebue LRRS has not been determined. Contaminant uptake by plants is dependent on many different factors specific to the plant species, including lipid, wax, and water contents and transpiration rates (Paterson et al. 1994), and has been the subject of many different models (e.g., Boüggemann 1993). The SCFs calculated for this baseline ecological risk assessment may differ from the true contaminant uptake factors for dietary species consumed by caribou and ground squirrels by one or more orders of magnitude. Therefore, the uncertainty of the risk estimates from the dietary pathway is greater than the uncertainty associated with risk estimates from the direct pathways (i.e., ingestion of soil and surface water).

The percentage of soil in the diet of ground squirrels represents an area of uncertainty. The percentage chosen (10 percent) is probably an overestimate of the true value, based on the fact that the dietary soil content in a number of small mammals was no higher than 7.7 percent. The magnitude of the uncertainty due to this assumption is probably minor in comparison with the other factors contributing to the uncertainty of the overall risk estimate.

An additional area of uncertainty, the derivation of a reference toxicity dose, was addressed by the use of uncertainty factors. These were conservative extrapolations from toxicity data for laboratory mammals, not caribou.

7.0 REFERENCES

Adamczewski, J.Z., R.J. Hudson, and C.C. Gates. 1993. Winter energy balance and activity of female caribou on Coats Island, Northwest Territories: the relative importance of foraging and body reserves. *Can. J. Zool.* 71: 1221-1229.

Alaska Department of Environmental Conservation. 1995. Water Quality Standard Regulations (18 AAC 70).

Alt, K.T. 1969. Taxonomy and ecology of the inconnu (*Stenodus leucichthys nelma*), in Alaska. Biological Papers of the University of Alaska, Number 12.

Andrews, E. 1986. Yukon River subsistence fall chum fisheries: An overview. Technical Paper No. 147. Alaska Department of Fish and Game, Division of Subsistence.

ATSDR. 1988a. Draft toxicological profile for DDD, DDE, and DDT. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1988b. Draft toxicological profile for 2,4-dinitrotoluene and 2,6-dinitrotoluene. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1988c. Draft toxicological profile for phenol. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1989a. Toxicological profile for chlordane. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry. ATSDR/PB-90-168709.

ATSDR. 1989b. Draft toxicological profile for di-n-butylphthalate. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1989c. Toxicological profile for alpha-, beta-, gamma-, and delta-hexachlorocyclohexane. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry. ATSDR/PB-90-171406.

ATSDR. 1991a. Draft toxicological profile for aldrin/dieldrin. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1991b. Draft toxicological profile for di(2-ethylhexyl)phthalate. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1991c. Draft toxicological profile for heptachlor/heptachlor epoxide. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1991d. Draft toxicological profile for trichloroethylene. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1992. Toxicological profile for 2-hexanone. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry. ATSDR/TP-91/18.

ATSDR. 1993a. Toxicological profile for endosulfan. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry. ATSDR/TP-91/16.

ATSDR. 1993b. Draft toxicological profile for naphthalene. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1993c. Toxicological profile for selected PCBs (Arochlor 1260, 1254, 1248, 1242, 1232, 1221, and 1016). U.S. Public Health Service. Agency for Toxic Substances and Disease Registry. ATSDR/TP-92/16.

ATSDR. 1993d. Draft toxicological profile for polycyclic aromatic hydrocarbons (PAHs). U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1993e. Draft toxicological profile for xylenes. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1994a. Draft toxicological profile for di-n-octylphthalate. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. 1994b. Draft toxicological profile for endrin and endrin aldehyde. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry.

Behrendt, H. and R. Brüggemann. 1993. Modelling the fate of organic chemicals in the soil plant environment: Model study of root uptake of pesticides. *Chemosphere*, 27(12): 2325-2332.

Beyer, W.N., E. Connor, and S. Gerould. 1992. Survey of soil ingestion by wildlife. Report to the Office of Policy, Planning, and Evaluation. U.S. Environmental Protection Agency. 26 pp.

Boersma, L., F.T. Lindstrom, C. McFarlane, and E.L. McCoy. 1988. Uptake of organic chemicals by plants: A theoretical model. *Soil Science*, 146(6): 403-417.

Boertje, R.D. 1990. Diet quality and intake requirements of adult female caribou of the Denali herd, Alaska. *Journal of Applied Ecology* (1990), 27: 420-434.

Briggs, G.G., R.H. Bromilow, A.A. Evans, and M. Williams. 1983. Relationships between lipophilicity and the distribution of non-ionized chemicals in barley shoots following uptake by the roots. *Pestic. Sci.*, 14: 482-500.

Briggs, G.G., R.H. Bromilow, and A.A. Evans. 1982. Relationship between lipophilicity and root uptake and translocation of non-ionized chemicals by barley. *Pestic. Sci.*, 13:495-504.

Burns, J.J., K.J. Frost, and L.F. Lowry (eds.). 1985. Marine mammal species accounts. Alaska Department of Fish and Game. Technical Bulletin No. 7.

Calabrese, E.J. and L.A. Baldwin. 1993. Performing Ecological Risk Assessments. Lewis Publishers, Chelsea, Mississippi. 257 pp.

California Environmental Protection Agency. 1994. Preliminary Endangerment Assessment Guidance Manual. Toxic Substances Control Division.

Cowherd, L., G.E. Muleski, P.J. Englehart, and D.A. Gillette. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites. Office of Health and Environmental Assessment. U.S. Environmental Protection Agency. Washington, D.C. EPA/600/8-85/002.

Crête, M., J. Huot, and L. Gauthier. 1990. Food selection during early lactation by caribou calving on the tundra in Quebec. *Arctic*. 43(1): 60-65.

Dau, J. 18 April 1995. Personal Communication (Telephone conversation with Mr. Tad Deshler, Tetra Tech, Redmond, Washington). Alaska Department of Fish and Game, Kotzebue, Alaska.

Divoky, G.J. and A.M. Springer. 1988. Pelagic and coastal birds. pp. 69-84. In: The environment and resources of the southeastern Chukchi Sea. A review of the scientific literature. M.J. Hameedi and A.S. Naidu (eds). Outer Continental Shelf Environmental Assessment Program, U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service.

Dragun, J. 1988. The soil chemistry of hazardous materials. Hazardous Materials Control Research Institute, Silver Spring, MD.

Erlick, J. 17 January 1995. Personal Communication (Telephone conversation with Mr. Tad Deshler, Tetra Tech, Inc., Redmond, Washington). Kotzebue IRA, Kotzebue, Alaska.

Eschmeyer, W.N., and E.S. Herald. 1983. A Field Guide to Pacific Coast Fishes. Houghton Mifflin Company, Boston, MA. 336 pp.

Fall, J.A. and C.J. Utermohle. 1993. An investigation of the sociocultural consequences of outer continental shelf development in Alaska. Chapter 17: Kotzebue, pp. 461-485. U.S. DOI/MMS, Alaska OCS Region, Social and Economic Studies Unit. Anchorage, Alaska.

Feder, H.M. and S.C. Jewett. 1988. Macrobenthos. pp. 51-61. In: The environment and resources of the southeastern Chukchi Sea. A review of the scientific literature. M.J. Hameedi and A.S. Naidu (eds). Outer Continental Shelf Environmental Assessment Program, U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service.

Flemming, R.H. and D. Heggarty. 1966. Oceanography of the southeastern Chukchi Sea. In: Environment of the Cape Thompson Region, Alaska. N.J. Wilimovsky and J.N. Wolfe (eds). U.S. Atomic Energy Commission, Division of Technical Information, Oak Ridge, TN.

Frost, K.J. and L.F. Lowry. 1988. Marine mammals. pp. 85-101. In: The environment and resources of the southeastern Chukchi Sea. A review of the scientific literature. M.J. Hameedi and A.S. Naidu (eds). Outer Continental Shelf Environmental Assessment Program, U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service.

Frost, K.J., L.F. Lowry, and J.J. Burns. 1985. Ringed seal monitoring: relationships of distribution, abundance, and reproductive success to habitat attributes and industrial activities. Alaska Department of Fish and Game, Fairbanks, Alaska.

Galster, W. and P. Morrison. 1976. Seasonal changes in body composition of the arctic ground squirrel, *Citellus undulatus*. Can. J. Zool. 54: 74-78.

Georgette, S. and H. Loon. 1993. Subsistence use of fish and wildlife in Kotzebue, A Northwest Alaska Regional Center. Alaska Department of Fish and Game, Division of Subsistence, Juneau, AK. Technical Paper No. 167.

Hameedi, M.J. 1988. Zooplankton. pp. 43-50. In: The environment and resources of the southeastern Chukchi Sea. A review of the scientific literature. M.J. Hameedi and A.S. Naidu (eds). Outer Continental Shelf Environmental Assessment Program, U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service.

Hayes, M.O. and C. Ruby. 1979. Oil spill vulnerability, coastal morphology, and sediment. Kotzebue Sound. Coastal Research Division, Department of Geology, University of South Carolina, Columbia, Annual Report. Research Unit 59. Task D-4.

Health Effects Assessment Summary Tables (HEAST). 1994. FY-1994-Annual. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C. EPA540/4-94/020.

Hobbie, J.E. 1984. The ecology of tundra ponds of the Arctic Coastal Plain: A community profile. FWS/OBS-83/25. U.S. Fish and Wildlife Service. 52 pp.

Johnson, W.R. 1988. Physical Oceanography. pp. 29-38. In: The environment and resources of the southeastern Chukchi Sea. A review of the scientific literature. M.J. Hameedi and A.S. Naidu (eds). Outer Continental Shelf Environmental Assessment Program, U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service.

Kinder, T.H., J.D. Schumacher, R.B. Tripp, and D. Pashinski. 1977. The physical oceanography of Kotzebue Sound, Alaska, during late summer, 1976. Department of Oceanography, University of Washington, Seattle, WA. Technical Report M77-99.

Long, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. National Oceanic and Atmospheric Administration, Seattle, Washington. NOAA Technical Memorandum NOS OMA 52.

Lowry, L.F., K.J. Frost, and J.J. Burns. 1980. Variability in the diet of ringed seals, *Phoca hispida*, in Alaska. Canadian Journal of Fisheries and Aquatic Sciences 37(12): 2254-2261.

McCulloch, D.S. and D. Hopkins. 1966. Evidence for an early recent warm interval in northwestern Alaska. Geol. Soc. Amer. Bull. 77:1089-1108.

MuColloch, D.S., D.W. Taylor, and M. Rubin. 1965. Stratigraphy, non-marine mollusks, and radiometric dates from Quaternary deposits in the Kotzebue Sound area, western Alaska. Journal of Geology 73:442-453.

Nagy, K.A. 1987. Field metabolic rate and food requirement scaling in mammals and birds. Ecol. Monogr. 57: 111-128.

Naidu, A.S. and G. Gardner. 1988. Marine geology. pp. 11-27. In: The environment and resources of the southeastern Chukchi Sea. A review of the scientific literature. M.J. Hameedi and A.S. Naidu (eds). Outer Continental Shelf Environmental Assessment Program, U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service.

Newell, A.J. and T.J. Sinnott. 1993. Draft sediment criteria for New York State. New York State Department of Environmental Conservation, Albany, New York.

Northwest Arctic Borough (NAB). 1992. Northwest Arctic Borough Comprehensive Plan. Volume 1 - Plan Document.

Paterson, S., D. Mackay, and C. McFarlane. 1994. A model of organic chemical uptake by plants from soil and the atmosphere. Environ. Sci. Technol., 28: 2259-2266.

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. Draft guidelines for the protection and management of aquatic sediment quality in Ontario. Water Resources Branch, Ontario Ministry of the Environment, Toronto, Ontario, Canada.

Raymond, J.A., M. Merritt, and C. Skaugstad. 1984. Nearshore fishes of Kotzebue Sound in summer. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development, Juneau, Alaska.

Raymond, J.A. 1988. Fish resources. pp. 63-68. In: The environment and resources of the southeastern Chukchi Sea. A review of the scientific literature. M.J. Hameedi and A.S. Naidu (eds). Outer Continental Shelf Environmental Assessment Program, U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service.

Registry of Toxic Effects of Chemicals (RTECS). 1994. On-line database. U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Library of Medicine, Bethesda, Maryland.

Sage, B. 1986. The Arctic and Its Wildlife. Facts on File Publications. New York, New York. 190 pp.

Schell, D.M., S. Saupe, and R. Johnson-McNichols. 1988. Primary productivity and nutrient dynamics. pp. 39-42. In: The environment and resources of the southeastern Chukchi Sea. A review of the scientific literature. M.J. Hameedi and A.S. Naidu (eds). Outer Continental Shelf Environmental Assessment Program, U.S. Department of Commerce, National Oceanic and Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service.

Schroeder, R., D.B. Andersen, and G. Hildreth. 1987. Subsistence use area mapping in ten Kotzebue Sound communities. Alaska Department of Fish and Game, Division of Subsistence, Juneau, AK. Technical Paper No. 130.

Scott, J.L. 1977. Surface sediments of the Noatak Delta, Northeast Kotzebue Sound, Alaska. M.S. thesis, University of Washington, Seattle, Washington. 96 pp. + appendices.

Shannon and Wilson, Inc. 1993. Environmental Site Assessment, Air to Ground Radio Facility, Kotzebue, Alaska. Prepared for the University of Alaska, Fairbanks Facilities Planning and Project Services.

SmartriskTM software. 1993-94 ed. Pioneer Environmental Consulting. Kirkland, WA.

Suter, G.W. (ed.). 1993. Ecological risk assessment. Lewis Publishers, Chelsea, Michigan.

The Mitre Corporation. 1990. General guidance for ecological risk assessment at Air Force Installations. Prepared for Human Systems Division IRP Program Office. The Mitre Corporation, Civil Systems Division, Brooks Air Force Base, Texas.

U.S. Army of Corps of Engineers (U.S. ACOE). 1984. Shore Protection Manual, Vol. 1. Prepared for Department of the Army, U.S. Army Corps of Engineers, Washington, DC.

U.S. Department of the Air Force. 1985. Installation Restoration Program Phase I-Records Search, AAC Northern Region. Prepared by Engineering Science (ES) for the United States Department of the Air Force (AFESC/DEV).

U.S. Department of the Air Force. 1990a. Installation Restoration Program Remedial Investigation/ Feasibility Study Kotzebue, LRRS, Alaska Stage I Final Report. Prepared by Woodward-Clyde for the United States Department of the Air Force (AFESC-HSD/YAQ).

U.S. Department of the Air Force. 1990b. Installation Restoration Program Remedial Investigation/ Feasibility Study Kotzebue LRRS, Alaska Stage II Draft Report. Prepared by Woodward-Clyde for the United States Department of the Air Force (AFESC-HSD/YAQ).

U.S. Department of the Air Force. 1992. Handbook to Support the Installation Restoration Program (IRP) Statements of Work. Volume I - Remedial Investigation/Feasibility Studies (RI/FS). USAF Environmental Restoration DIV Staff. May 1991 (Reprint 1992).

U.S. Department of the Air Force. 1993. Natural Resources Plan, North Coastal Long Range Radar Stations. Draft. 11th Air Control Wing/11th Civil Engineering Operations Squadron.

U.S. Department of the Air Force. 1994a. Final Work Plan. Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study, Kotzebue Long Range Radar Station, Alaska. Prepared by Tetra Tech for the U.S. Department of the Air Force Center for Environmental Excellence (AFCEE/ERD).

U.S. Department of the Air Force. 1994b. Final Field Sampling Plan. Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study, Kotzebue Long Range Radar Station, Alaska. Prepared by Tetra Tech for the U.S. Department of the Air Force Center for Environmental Excellence (AFCEE/ERD).

U.S. Department of the Air Force. 1994c. Final Quality Assurance Project Plan. Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study, Kotzebue Long Range Radar Station, Alaska. Prepared by Tetra Tech for the U.S. Department of the Air Force Center for Environmental Excellence (AFCEE/ERD).

U.S. Department of the Air Force. 1994d. Final Health and Safety Plan. Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study, Kotzebue Long Range Radar Station, Alaska. Prepared by Tetra Tech for the U.S. Department of the Air Force Center for Environmental Excellence (AFCEE/ERD).

U.S. Department of the Air Force. 1995a. RI/FS Report. Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study, Kotzebue Long Range Radar Station, Alaska. Prepared by Tetra Tech for the U.S. Department of the Air Force Center for Environmental Excellence (AFCEE/ERD).

U.S. Department of the Air Force. 1995b. Analytical Data Informal Technical Information Report. Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study, Kotzebue Long Range Radar Station, Alaska. Prepared by Tetra Tech for the U.S. Department of the Air Force Center for Environmental Excellence (AFCEE/ERD).

U.S. Department of Commerce. 1983. Local climatological data: Kotzebue, Alaska. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data and Information Service, National Climatic Data Center, Asheville, North Carolina.

U.S. Department of Commerce. 1986. Comparative climatic data for the United States through 1986. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data and Information Service, National Climatic Data Center, Asheville, NC.

U.S. Department of Commerce. 1992. 1992 tidal current and tide tables. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Washington, DC.

U.S. EPA (U.S. Environmental Protection Agency). 1988. Guidance for conducting remedial investigations and feasibility studies under CERCLA. OSWER Directive 9355.3-01.

U.S. EPA (U.S. Environmental Protection Agency). 1989a. Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual, Office of Emergency and Remedial Response, Washington, DC. EPA/540/1-89/002.

U.S. EPA (U.S. Environmental Protection Agency). 1989b. Risk assessment guidance for Superfund. Volume II. Environmental evaluation manual. EPA/540/1-89/001. U.S. EPA, Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA (U.S. Environmental Protection Agency). 1989c. Assessing human health risks from chemically contaminated fish and shellfish: A guidance manual. EPA-503/8-89-002. U.S. EPA, Office of Marine and Estuarine Protection, Washington, DC.

U.S. EPA (U.S. Environmental Protection Agency). 1990a. Exposure Factors Handbook. Office of Health and Environmental Assessment, Washington, DC. EPA/600/8-89-043.

U.S. EPA (U.S. Environmental Protection Agency). 1990b. Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions, Office of Health and Environmental Assessment, Washington, DC. EPA/600/6-90/003.

U.S. EPA (U.S. Environmental Protection Agency). 1990c. National Oil and Hazardous Substances Pollution Contingency Plan (NCP). 55 Federal Register 8666.

U.S. EPA (U.S. Environmental Protection Agency). 1990d. Guidance for data useability in risk assessment. Interim Final. EPA/540/G-90/008. U.S. EPA, Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA (U.S. Environmental Protection Agency). 1991a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, Office of Emergency and Remedial Response, Washington, DC. OSWER Directive 9285.6-03.

U.S. EPA (U.S. Environmental Protection Agency). 1991b. Human Health Evaluation Manual, Part B: Development of Risk-based Preliminary Remediation Goals, Office of Emergency and Remedial Response, Washington, D.C. OSWER Directive 9285.7-01B.

U.S. EPA (U.S. Environmental Protection Agency). 1991c. Supplemental Guidance for Superfund Risk Assessments in Region X. Health and Environmental Assessment Division, Seattle, WA.

U.S. EPA (U.S. Environmental Protection Agency). 1991d. Ambient water quality criteria summary. Office of Science and Technology, Health and Ecological Criteria Division. Washington, DC.

U.S. EPA (U.S. Environmental Protection Agency). 1992a. Dermal Exposure Assessment: Principles and Applications. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-91/011B.

U.S. EPA (U.S. Environmental Protection Agency). 1992b. Framework for ecological risk assessment. EPA/630/R-92/001. Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, D.C.

U.S. EPA (U.S. Environmental Protection Agency). 1993a. Water Quality Guidance for the Great Lakes System and Correction: Proposed Rules. U.S. EPA, Washington, DC. Federal Register Vol. 58, No. 72, Part II. pp. 20802-21047.

U.S. EPA (U.S. Environmental Protection Agency). 1993b. Wildlife Exposure Factors Handbook. U.S. EPA, Office of Research and Development, Washington, DC. EPA/600/R-93/187a.

U.S. EPA (U.S. Environmental Protection Agency). 1994a. Contract Laboratory Program National Guidelines for Inorganic Data Review. EPA-540/R-94/013.

U.S. EPA (U.S. Environmental Protection Agency). 1994b. Contract Laboratory Program National Guidelines for Organic Data Review. EPA-540/R-94/012.

U.S. EPA (U.S. Environmental Protection Agency). 1994c. Health Effects Assessment Summary Tables (HEAST).

U.S. EPA (U.S. Environmental Protection Agency). 1994d. Integrated Risk Information System (IRIS).

U.S. EPA (U.S. Environmental Protection Agency). 1994e. Region III Risk Based Concentration Table, Fourth Quarter, Philadelphia, PA.

Wang, M.J. and K.C. Jones. 1994. Behavior and fate of chlorobenzenes (CBs) introduced into soil-plant systems by sewage sludge application: A review. *Chemosphere*, 28(7):1325-1360.

Wiedemeier et al. 1994. (Draft) Technical Protocol for Data Collection and Modeling in Support of Intrinsic Remediation (Natural Attenuation) for Dissolved-Phase Fuel Contamination in Groundwater.

APPENDIX A

CONTAMINANT ANALYSES FOR EACH INVESTIGATIVE AREA

APPENDIX A

CONTAMINANT ANALYSES FOR EACH INVESTIGATIVE AREA

CONTENTS

- A-1 List of Chemicals Detected in East Drainage Area
- A-2 List of Chemicals Detected in West Drainage Area
- A-3 List of Chemicals Detected in White Alice Area
- A-4 List of Chemicals Detected in Beach Area

TABLE A-1. LIST OF CHEMICALS DETECTED IN EAST DRAINAGE AREA
(Page 1 of 6)

Parameter	SS7				AOC1				AOC3				AOC5				AOC7				SS8				
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	
Metals																									
Aluminum	●		●			●				●												●			
Antimony	○		○			●				●												○			
Arsenic	●		○			●				●												●			
Barium	●		●			●				●												●			
Beryllium	●		○			●				●												●			
Cadmium	○		○			○																○			
Calcium	●		●			●				●												●			
Chromium, total	●		○			○				●												●			
Cobalt	●		○			○				●												●			
Copper	●		●			●				●												●			
Iron	●		●			●				●												●			
Lead	●		○			○				●												●			
Magnesium			●			●				●												●			
Manganese	●		●			●				●												●			
Mercury	●		○			○				●												●			
Molybdenum	○		○			○				○												○			
Nickel	●		○			○				●												●			
Potassium	●		●			●				●												●			
Selenium	○		○			○				●												●			
Silica																									
Silver			○			○				○												●			
Sodium	●		●			●				●												●			
Thallium	●		○			○				●												●			
Vanadium	●		○			○				●												●			
Zinc	●		●			●				●												●			

TABLE A-1. LIST OF CHEMICALS DETECTED IN EAST DRAINAGE AREA
(Page 2 of 6)

Parameter	SS7				AOC1				AOC3				AOC5				AOC7				SS8				
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	
Pesticides/PCBs																									
4,4'-DDD	●	●	○						●									●							
4,4'-DDE	●	●	○						●									●							
4,4'-DDT	●	●	○						●									●							
Aldrin	○	○	○						○									○							
alpha BHC	●	○	○						●									○							
alpha-Chlordane	○	○	○						○									○							
Arochlor 1016	○	○	○						○									○							
Arochlor 1221	○	○	○						○									○							
Arochlor 1232	○	○	○						○									○							
Arochlor 1242	○	○	○						○									○							
Arochlor 1248	○	○	○						○									○							
Arochlor 1254	○	○	○						○									○							
Arochlor 1260	○	○	○						○									○							
beta BHC	○	○	○						●									○							
delta BHC	○	●	○						●									○							
Dieldrin	○	○	○						○									○							
Endosulfan I	○	○	○						●									○							
Endosulfan II	○	○	○						○									○							
Endosulfan Sulfate	○	○	○						○									○							
Endrin	●	●	○						●									●							
Endrin Aldehyde	○	○	○						○									○							
gamma BHC (Lindane)	●	●	○						●									○							
gamma-Chlordane	○	○	○						○									○							
Heptachlor	○	○	○						○									○							
Heptachlor Epoxide	●	○	●						●									●							
Methoxychlor	○	○	○						○									○							
Toxaphene	○	○	○						○									○							

TABLE A-1. LIST OF CHEMICALS DETECTED IN EAST DRAINAGE AREA
(Page 3 of 6)

Parameter	SS7			AOC1			AOC3			AOC5			AOC7			SS8		
	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW
Volatile Organics																		
1,1,1,2-Tetrachloroethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,1,1-Trichloroethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,1,2,2-Tetrachloroethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,1,2-Trichloro-1,2,2-trifluoroethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,1,2-Trichloroethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,1-Dichloroethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,1-Dichloroethene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,2,3-Trichloropropane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,2-Dichloroethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1,2-Dichloropropane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
1-Chlorohexane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2-Chloroethyl Vinyl Ether	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2-Hexanone	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Acetone	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Benzene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Bromobenzene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Bromochloromethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Bromodichloromethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Bromoform	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Bromomethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Carbon Disulfide	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Carbon Tetrachloride	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Chlorobenzene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Chloroethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Chloroform	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Chloromethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
cis-1,2-Dichloroethylene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
cis-1,3-Dichloropropene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Dibromochloromethane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

TABLE A-1. LIST OF CHEMICALS DETECTED IN EAST DRAINAGE AREA
(Page 4 of 6)

Parameter	SS7			AOC1			AOC3			AOC5			AOC7			SS8		
	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW
Volatile Organics (Cont.)																		
Ethylbenzene	●		○		●	○		○			●			○			○	
m,p-xylene					○													
Methyl Ethyl Ketone (2-butanone)	●		○		●	○		●			●			○			○	
Methyl Isobutyl Ketone	○		○		○	○		○			○			○			○	
Methylene Chloride	●		○		●	○		●			●			●			●	
o-xylene					○													
Styrene	○		○		○	○		○			○			○			○	
Tetrachloroethylene (PCE)	○		○		●	○		○			○			○			○	
Toluene	○		○		●	○		○			●			○			○	
trans-1,2-Dichloroethene	○		○		○	○		○			○			○			○	
trans-1,3-Dichloropropene	○		○		○	○		○			○			○			○	
Trichloroethylene (TCE)	○		○		●	○		○			●			○			○	
Vinyl Acetate	○		○		○	○		○			○			○			○	
Vinyl Chloride	○		○		○	○		○			○			○			○	
Xylenes, total	●		○		●	○		●			●			○			○	
Semivolatile Organics																		
1,2,4-Trichlorobenzene	○		○		○			○			○			○			○	
1,2-Dichlorobenzene	○		○		○			○			○			○			○	
1,3-Dichlorobenzene	○		○		○			○			○			○			○	
1,4-Dichlorobenzene	○		○		○			○			○			○			○	
2,2'-xylybis (1-Chloropropane)	○		○		○			○			○			○			○	
2,4,5-Trichlorophenol	○		○		○			○			○			○			○	
2,4,6-Trichlorophenol	○		○		○			○			○			○			○	
2,4-Dichlorophenol	○		○		○			○			○			○			○	
2,4-Dimethylphenol	○		○		○			○			○			○			○	
2,4-Dinitrophenol	○		○		○			○			○			○			○	
2,4-Dinitrotoluene	○		○		○			○			○			○			○	
2,6-Dinitrotoluene	○		○		○			○			○			○			○	
2-Chloronaphthalene	○		○		○			○			○			○			○	

TABLE A-1. LIST OF CHEMICALS DETECTED IN EAST DRAINAGE AREA
(Page 5 of 6)

Parameter	SS7			AOC1			AOC3			AOC5			AOC7			SS8		
	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW
Semivolatile Organics (Cont.)																		
2-Chlorophenol	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2-Methylnaphthalene	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2-Methylphenol	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2-Nitroaniline	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2-Nitrophenol	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3,3'-Dichlorobenzidine	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
3-Nitroaniline	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4,6-Dinitro-2-Methylphenol	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4-Bromophenyl Phenyl Ether	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4-Chloro-3-Methylphenol	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4-Chloroaniline	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4-Chlorophenyl Phenyl Ether	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4-Methylphenol	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4-Nitroaniline	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
4-Nitrophenol	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Acenaphthene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Acenaphthylene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Anthracene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Benzo(a)anthracene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Benzo(a)pyrene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Benzo(b)fluoranthene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Benzo(g,h,i)perylene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Benzo(k)fluoranthene	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Benzoic Acid	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Benzyl Alcohol	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
bis(2-Chloroethoxy) Methane	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
bis(2-Chloroethyl) Ether	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
bis(2-Ethylhexyl) Phthalate	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Butylbenzylphthalate	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

TABLE A-1. LIST OF CHEMICALS DETECTED IN EAST DRAINAGE AREA
(Page 6 of 6)

Parameter	SS7				AOC1				AOC3				AOC5				AOC7				SS8				
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	
Semivolatle Organics (Cont.)																									
Chrysene	○		○							○					○							○			
di-n-butyl Phthalate	○		○							○					○							○			
di-n-Octylphthalate	○		○							○					○							○			
Dibenzo(a,h)anthracene	○		○							○					○							○			
Dibenzofuran	○		○							○					●							●			
Diethyl Phthalate	○		○							○					○							○			
Dimethyl Phthalate	○		○							○					○							○			
Fluoranthene	○		○							●					●							●			
Fluorene	○		○							●					●							●			
Hexachlorobenzene	○		○							○					○							○			
Hexachlorobutadiene	○		○							○					○							○			
Hexachlorocyclopentadiene	○		○							○					○							○			
Hexachloroethane	○		○							○					○							○			
Indeno(1,2,3-c,d)pyrene	○		○							○					○							○			
Isophorone	○		○							○					●							○			
N-Nitrosodi-n-propylamine	○		○							○					○							○			
N-Nitrosodiphenylamine	○		○							○					○							○			
Naphthalene	○		○							●					●							●			
Nitrobenzene	○		○							○					●							●			
Pentachlorophenol	○		○							○					○							○			
Phenanthrene	○		○							●					●							●			
Phenol	○		○							○					○							○			
Pyrene	○		○							●					●							●			
Miscellaneous																									
Total Organic Carbon																									
Gasoline Hydrocarbons															●										
AK102-Extended	●									●															
Diesel Hydrocarbons	●		○							●					●								●		
○ = Non-detected ● = Detected Blanks indicate sample not analyzed.																									

○ = Non-detected ● = Detected Blanks indicate sample not analyzed.

TABLE A-2. LIST OF CHEMICALS DETECTED IN WEST DRAINAGE AREA
(Page 1 of 6)

Parameter	SS12				AOC11				AOC12				AOC2				AOC4				
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	
Metals																					
Aluminum											●								●		
Antimony											○								○		
Arsenic											●								●		
Barium											●								●		
Beryllium											●								●		
Cadmium											○								○		
Calcium			●								●								●		
Chromium, total											●								●		
Cobalt											●								●		
Copper											●								●		
Iron			●								●								●		
Lead											●								●		
Magnesium			●								●								●		
Manganese											●								●		
Mercury											●								●		
Molybdenum											○								○		
Nickel											●								●		
Potassium			●								●								●		
Selenium											●								●		
Silica																					
Silver											○								○		
Sodium			●								●								●		
Thallium											●								●		
Vanadium											●								●		
Zinc											●								●		

TABLE A-2. LIST OF CHEMICALS DETECTED IN WEST DRAINAGE AREA
(Page 2 of 6)

Parameter	SS12				AOC11				AOC12				AOC2				AOC4				
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	
Pesticides/PCBS																					
4,4'-DDD	●	●	●											○					●		
4,4'-DDE	●	●	○											○					●		
4,4'-DDT	●	●	●											●					●		
Aldrin	●	○	●											○					●		
alpha BHC	●	●	●											○					●		
alpha-Chlordane	●	○	○											○					○		
Arochlor 1016	○	○	○											○					○		
Arochlor 1221	○	○	○											○					○		
Arochlor 1232	○	○	○											○					○		
Arochlor 1242	○	○	○											○					○		
Arochlor 1248	○	○	○											○					○		
Arochlor 1254	○	○	○											○					○		
Arochlor 1260	○	●	○											○					○		
beta BHC	○	●	●											○					○		
delta BHC	●	●	○											○					○		
Dieldrin	●	●	●											○					●		
Endosulfan I	○	○	○											○					○		
Endosulfan II	○	○	○											○					○		
Endosulfan Sulfate	○	○	●											○					○		
Endrin	○	●	○											○					●		
Endrin Aldehyde	○	●	○											○					○		
gamma BHC (Lindane)	○	●	○											○					●		
gamma-Chlordane	○	●	○											○					●		
Heptachlor	○	●	●											○					●		
Heptachlor Epoxide	●	●	●											●					○		
Methoxychlor	○	○	○											○					○		
Toxaphene	○	○	○											○					○		

TABLE A-2. LIST OF CHEMICALS DETECTED IN WEST DRAINAGE AREA
(Page 3 of 6)

Parameter	SS12				AOC11				AOC12				AOC2				AOC4			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Volatile Organics																				
1,1,1,2-Tetrachloroethane	○	○	○			○				○				○				○		
1,1,1-Trichloroethane	○	○	○			○				○				○				○		
1,1,2,2-Tetrachloroethane	○	○	○			○				○				○				○		
1,1,2-Trichloro-1,2,2-trifluoroethane	○	○	○			○				○				○				○		
1,1,2-Trichloroethane	○	○	○			○				○				○				○		
1,1-Dichloroethane	○	○	○			○				○				○				○		
1,1-Dichloroethene	○	○	○			○				○				○				○		
1,2,3-Trichloropropane	○	○	○			○				○				○				○		
1,2-Dichloroethane	○	○	○			○				○				○				○		
1,2-Dichloropropane	○	○	○			○				○				○				○		
1-Chlorohexane	○	○	○			○				○				○				○		
2-Chloroethyl Vinyl Ether	○	○	○			○				○				○				○		
2-Hexanone	○	●	○			○				○				○				○		
Acetone	●	●	●			●				●				●				●		
Benzene	○	●	○			○				○				○				○		
Bromobenzene	○	○	○			○				○				○				○		
Bromochloromethane	○	○	○			○				○				○				○		
Bromodichloromethane	○	○	○			○				○				○				○		
Bromoform	○	○	○			○				○				○				○		
Bromomethane	○	○	○			○				○				○				○		
Carbon Disulfide	○	○	○			○				○				○				○		
Carbon Tetrachloride	○	○	○			○				○				○				○		
Chlorobenzene	○	●	○			○				○				○				○		
Chloroethane	○	○	○			○				○				○				○		
Chloroform	○	○	○			○				○				○				○		
Chloromethane	○	○	○			○				○				○				○		
cis-1,2-Dichloroethylene	○	○	○			○				○				○				○		
cis-1,3-Dichloropropene	○	○	○			○				○				○				○		
Dibromochloromethane	○	○	○			○				○				○				○		

TABLE A-2. LIST OF CHEMICALS DETECTED IN WEST DRAINAGE AREA
(Page 4 of 6)

Parameter	SS12				AOC11				AOC12				AOC2				AOC4			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Volatile Organics (Cont.)																				
Ethylbenzene	○	●	○			○								○				○		
m,p-xylene																				
Methyl Ethyl Ketone (2-butanone)	●	●	●			○								○				○		
Methyl Isobutyl Ketone	○	○	○			○								○				○		
Methylene Chloride	●	●	○			●								●				●		
o-xylene																				
Styrene	○	○	○			○								○				○		
Tetrachloroethylene (PCE)	○	○	○			○								○				○		
Toluene	○	●	●			○								○				○		
trans-1,2-Dichloroethene	○	○	○			○								○				○		
trans-1,3-Dichloropropene	○	○	○			○								○				○		
Trichloroethylene (TCE)	○	●	○			○								○				○		
Vinyl Acetate	○	○	○			○								○				○		
Vinyl Chloride	○	○	○			○								○				○		
Xylenes, total	○	●	○			○								○				●		
Semivolatile Organics																				
1,2,4-Trichlorobenzene	○	○	○			○								○				○		
1,2-Dichlorobenzene	○	○	○			○								○				○		
1,3-Dichlorobenzene	○	○	●			○								○				○		
1,4-Dichlorobenzene	○	○	○			○								○				○		
2,2'-Oxybis (1-Chloropropane)	○	○	○			○								○				○		
2,4,5-Trichlorophenol	○	○	○			○								○				○		
2,4,6-Trichlorophenol	○	○	○			○								○				○		
2,4-Dichlorophenol	○	●	○			○								○				○		
2,4-Dimethylphenol	●	●	○			○								○				○		
2,4-Dinitrophenol	○	○	○			○								○				○		
2,4-Dinitrotoluene	●	●	○			○								○				○		
2,6-Dinitrotoluene	●	●	○			○								○				○	●	
2-Chloronaphthalene	○	○	○			○								○				○		

TABLE A-2. LIST OF CHEMICALS DETECTED IN WEST DRAINAGE AREA
(Page 5 of 6)

Parameter	SS12				AOC11				AOC12				AOC2				AOC4			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Semivolatile Organics (Cont.)																				
2-Chlorophenol	○	○	○			○								○				○		
2-Methylnaphthalene	○	●	○			○								○	●			●		
2-Methylphenol	○	○	○			○								○	○			○		
2-Nitroaniline	●	●	●			○								○	●			●		
2-Nitrophenol	●	●	○			○	●							○	●			●		
3,3'-Dichlorobenzidine	○	○	○			○								○	○			○		
3-Nitroaniline	●	●	○			○								○	○			○		
4,6-Dinitro-2-Methylphenol	○	○	○			○								○				○		
4-Bromophenyl Phenyl Ether	○	○	○			○								○				○		
4-Chloro-3-Methylphenol	○	●	○			○								○	●			○		
4-Chloroaniline	○	●	○			○								○	○			○		
4-Chlorophenyl Phenyl Ether	○	○	○			○								○	○			○		
4-Methylphenol	○	●	○			○								○	○			○		
4-Nitroaniline	○	○	○			○								○	○			○		
4-Nitrophenol	●	●	●			○								○	●			●		
Acenaphthene	○	●	○			○								○	○			○		
Acenaphthylene	○	○	●			○								○	○			○		
Anthracene	○	●	○			○								○	○			○		
Benzo(a)anthracene	○	●	○			○								○	○			○		
Benzo(a)pyrene	○	○	○			○								○	○			○		
Benzo(b)fluoranthene	○	○	○			○								○	○			○		
Benzo(g,h,i)perylene	○	○	○			○								○	○			○		
Benzo(k)fluoranthene	○	○	○			○								○	○			○		
Benzoic Acid	○	●	○			○								○	●			●		
Benzyl Alcohol	○	○	○			○								○	○			○		
bis(2-Chloroethoxy) Methane	○	●	○			○								○	○			○		
bis(2-Chloroethyl) Ether	○	○	○			○								○	○			○		
bis(2-Ethylhexyl) Phthalate	●	●	●			○	●							○	●			●		
Burylbenzylphthalate	○	○	○			○								○	○			○		

TABLE A-2. LIST OF CHEMICALS DETECTED IN WEST DRAINAGE AREA
(Page 6 of 6)

Parameter	SS12			AOC11			AOC12			AOC2			AOC4		
	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW	Sed	Soil	SW
Semivolatiles Organics (Cont.)															
Chrysene	○	●	○		○			○			○			○	
di-n-butyl Phthalate	○	○	○		○			○			○			○	
di-n-Octylphthalate	○	○	○		○			○			○			○	
Dibenzo(a,h)anthracene	○	○	○		○			○			○			○	
Dibenzofuran	○	●	●		○			○			○			●	
Diethyl Phthalate	○	○	○		○			○			○			○	
Dimethyl Phthalate	○	○	○		○			○			○			○	
Fluoranthene	○	●	○		○						○			○	
Fluorene	○	●	○		○						●			●	
Hexachlorobenzene	○	○	○		○			○			○			○	
Hexachlorobutadiene	○	○	○		○			○			○			○	
Hexachlorocyclopentadiene	○	○	○		○			○			○			○	
Hexachloroethane	○	○	○		○			○			○			○	
Indeno(1,2,3-c,d)pyrene	○	○	○		○			○			○			○	
Isophorone	●	●	●		○			○			●			○	
N-Nitrosodi-n-propylamine	○	○	○		○			○			○			○	
N-Nitrosodiphenylamine	○	○	○		○			○			○			○	
Naphthalene	○	●	○		○			○			○			●	
Nitrobenzene	○	●	○		○			○			●			○	
Pentachlorophenol	○	○	○		○			○			○			○	
Phenanthrene	○	●	○		○			○			●			●	
Phenol	○	●	○		○			○			○			○	
Pyrene	○	●	○		○			○			●			○	
Miscellaneous															
Total Organic Carbon			●												
Gasoline Hydrocarbons					●									●	
AK102-Extended															
Diesel Hydrocarbons	●	●	●		●						●			●	

○ = Non-detected ● = Detected Blanks indicate sample not analyzed.

TABLE A-3. LIST OF CHEMICALS DETECTED IN WHITE ALICE AREA

(Page 1 of 6)

Parameter	AOC6				AOC8				AOC9				SS11			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Metals																
Aluminum	●	●	●			●										
Antimony	○	○	○			●										
Arsenic	●	●	○			●										
Barium	●	●	●			●										
Beryllium	●	●	○			●										
Cadmium	○	○	○			○										
Calcium	●	●	●			●										
Chromium, total	●	●	○			●										
Cobalt	●	●	○			●										
Copper	●	●	●			●										
Iron	●	●	●			●										
Lead	●	●	●			●										
Magnesium	●	●	●			●										
Manganese	●	●	●			●										
Mercury	○	●	○			●										
Molybdenum	○	○	○			○										
Nickel	●	●	●			●										
Potassium	●	●	●			●										
Selenium	●	●	○			●										
Silica																
Silver	○	●	○			○										
Sodium	●	●	●			●										
Thallium	●	●	○			●										
Vanadium	●	●	○			●										
Zinc	●	●	●			●										

TABLE A-3. LIST OF CHEMICALS DETECTED IN WHITE ALICE AREA
(Page 2 of 6)

Parameter	AOC6				AOC8				AOC9				SS11			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Pesticides/PCBs																
4,4'-DDD	●	●	○			●				●			●	●	●	
4,4'-DDE	●	●	○			●				●			●	●	○	
4,4'-DDT	●	●	○			●				●			●	●	○	
Aldrin	○	●	○			●				○			○	○	○	
alpha BHC	○	●	○			●				●			○	○	○	
alpha-Chlordane	○	●	○			○				○			○	○	○	
Arochlor 1016	○	○	○			○				○			○	○	○	
Arochlor 1221	○	○	○			○				○			○	○	○	
Arochlor 1232	○	○	○			○				○			○	○	○	
Arochlor 1242	○	○	○			○				○			○	○	○	
Arochlor 1248	○	○	○			○				○			○	○	○	
Arochlor 1254	●	●	○			●				○			○	○	○	
Arochlor 1260	●	○	○			○				○			○	○	○	
beta BHC	○	●	○			●				○			○	○	○	
delta BHC	○	○	○			○				○			○	○	○	
Dieldrin	○	○	○			○				○			○	○	○	
Endosulfan I	○	●	○			○				○			○	○	○	
Endosulfan II	○	○	○			○				○			○	○	○	
Endosulfan Sulfate	○	○	○			○				○			○	○	○	
Endrin	●	●	○			●				●			●	○	○	
Endrin Aldehyde	○	●	○			○				○			○	○	○	
gamma BHC (Lindane)	○	●	○			○				○			○	○	○	
gamma-Chlordane	●	●	○			●				○			○	○	○	
Heptachlor	○	●	○			○				○			○	○	○	
Heptachlor Epoxide	○	●	○			○				○			○	○	○	
Methoxychlor	○	●	○			○				○			○	○	○	
Toxaphene	○	○	○			○				○			○	○	○	

TABLE A-3. LIST OF CHEMICALS DETECTED IN WHITE ALICE AREA
(Page 3 of 6)

Parameter	AOC6				AOC8				AOC9				SS11			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Volatile Organics																
1,1,1,2-Tetrachloroethane	○	○	○			○				○			○	○	○	
1,1,1-Trichloroethane	○	○	○			○				○			○	○	○	
1,1,2,2-Tetrachloroethane	○	○	○			○				○			○	○	○	
1,1,2-Trichloro-1,2,2-trifluoroethane	○	○	○			●				○			●	○	○	
1,1,2-Trichloroethane	○	○	○			○				○			○	○	○	
1,1-Dichloroethane	○	○	○			○				○			○	○	○	
1,2,3-Trichloropropane	○	○	○			○				○			○	○	○	
1,2-Dichloroethane	○	○	○			○				○			○	○	○	
1,2-Dichloropropane	○	○	○			○				○			○	○	○	
1-Chlorohexane	○	○	○			○				○			○	○	○	
2-Chloroethyl Vinyl Ether	○	○	○			○				○			○	○	○	
2-Hexanone	○	○	○			○				○			○	○	○	
Acetone	○	○	●			●				○	●		○	○	●	
Benzene	○	○	○			○				○			○	○	○	
Bromobenzene	○	○	○			○				○			○	○	○	
Bromochloromethane	○	○	○			○				○			○	○	○	
Bromodichloromethane	○	○	○			○				○			○	○	○	
Bromoform	○	○	○			○				○			○	○	○	
Bromomethane	○	○	○			○				○			○	○	○	
Carbon Disulfide	○	○	○			○				○			○	○	○	
Carbon Tetrachloride	○	○	○			○				○			○	○	○	
Chlorobenzene	○	○	○			○				○			○	○	○	
Chloroethane	○	○	○			○				○			○	○	○	
Chloroform	○	○	○			○				○			○	○	○	
Chloromethane	○	○	○			○				○			○	○	○	
cis-1,2-Dichloroethylene	○	○	○			○				○			○	○	○	
cis-1,3-Dichloropropene	○	○	○			○				○			○	○	○	
Dibromochloromethane	○	○	○			○				○			○	○	○	

TABLE A-3. LIST OF CHEMICALS DETECTED IN WHITE ALICE AREA
(Page 4 of 6)

Parameter	AOC6				AOC8				AOC9				SS11			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Volatile Organics (Cont.)																
Ethylbenzene	○	○	○			○							●	○	○	
m,p-xylene																
Methyl Ethyl Ketone (2-butanone)	○	○	○			○				●			●	○	○	
Methyl Isobutyl Ketone	○	○	○			○				○			○	○	○	
Methylene Chloride	●	●	●			●				●			●	●	○	
o-xylene																
Styrene	○	○	○			○				○			○	○	○	
Tetrachloroethylene (pce)	○	○	○			○				○			○	○	○	
Toluene	○	●	○			●				○			○	○	○	
trans-1,2-Dichloroethene	○	○	○			○				○			○	○	○	
trans-1,3-Dichloropropene	○	○	○			○				○			○	○	○	
Trichloroethylene (tce)	○	○	○			○				○			○	●	○	
Vinyl Acetate	○	○	○			○				○			○	○	○	
Vinyl Chloride	○	○	○			○				○			○	○	○	
Xylenes, total	○	○	○			●				○			●	○	○	
Semivolatile Organics																
1,2,4-Trichlorobenzene	○	●	○			○				○			○	○	○	
1,2-Dichlorobenzene	○	○	○			○				○			○	○	○	
1,3-Dichlorobenzene	○	○	○			○				○			○	○	●	
1,4-Dichlorobenzene	○	○	○			○				○			○	○	○	
2,2'-Oxybis (1-Chloropropane)	○	○	○			○				○			○	○	○	
2,4,5-Trichlorophenol	○	○	○			○				○			○	○	○	
2,4,6-Trichlorophenol	○	○	○			○				○			○	○	○	
2,4-Dichlorophenol	○	●	○			○				○			○	○	○	
2,4-Dimethylphenol	○	●	○			●				○			○	○	○	
2,4-Dinitrophenol	○	○	○			○				○			○	○	○	
2,4-Dinitrotoluene	○	●	○			●				○			○	○	○	
2,6-Dinitrotoluene	○	○	○			○				○			○	○	○	
2-Chloronaphthalene	○	○	○			○				○			○	○	○	

TABLE A-3. LIST OF CHEMICALS DETECTED IN WHITE ALICE AREA
(Page 5 of 6)

Parameter	AOC6				AOC8				AOC9				SS11			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Semivolatle Organics (Cont.)																
2-Chlorophenol	○	○	○			○				○			○	○	○	
2-Methylnaphthalene	○	●	○			●				○			○	○	○	
2-Methylphenol	○	○	○			○				○			○	○	○	
2-Nitroaniline	○	●	○			●				○			●	○	○	
2-Nitrophenol	○	●	○			●				●			●	○	○	
3,3'-Dichlorobenzidine	○	○	○			○				○			○	○	○	
3-Nitroaniline	○	○	○			●				○			○	○	○	
4,6-Dinitro-2-Methylphenol	○	○	○			○				○			○	○	○	
4-Bromophenyl Phenyl Ether	○	○	○			○				○			○	○	○	
4-Chloro-3-Methylphenol	○	○	○			○				○			○	○	○	
4-Chloroaniline	○	●	○			○				○			○	○	○	
4-Chlorophenyl Phenyl Ether	○	●	○			○				○			○	○	○	
4-Methylphenol	○	○	○			●				○			●	○	○	
4-Nitroaniline	○	○	○			○				○			○	○	○	
4-Nitrophenol	○	○	○			○				○	●		○	○	○	
Acenaphthene	○	●	○			○				○			○	○	○	
Acenaphthylene	○	○	○			○				○			○	○	○	
Anthracene	○	○	○			○				○			○	○	○	
Benzo(a)anthracene	○	○	○			●				○			○	○	○	
Benzo(a)pyrene	○	○	○			●				○			○	○	○	
Benzo(b)fluoranthene	○	○	○			●				○			○	○	○	
Benzo(g,h,i)perylene	○	○	○			○				○			○	○	○	
Benzo(k)fluoranthene	○	○	○			○				○			○	○	○	
Benzoic Acid	○	●	○			●				○			○	○	○	
Benzyl Alcohol	○	○	○			○				○			○	○	○	
bis(2-Chloroethoxy) Methane	○	○	○			○				○			○	○	○	
bis(2-Chloroethyl) Ether	○	○	○			○				○			○	○	○	
bis(2-Ethylhexyl) Phthalate	○	●	●			●				○			●	○	○	
Butylbenzylphthalate	○	○	○			○				○			○	○	○	

TABLE A-3. LIST OF CHEMICALS DETECTED IN WHITE ALICE AREA
(Page 6 of 6)

Parameter	AOC6			AOC8			AOC9			SS11		
	Sed	Soil	SW	GW	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Semivolatiles Organics (Cont.)												
Chrysene	○	○	○			●				○	○	○
di-n-butyl Phthalate	○	○	○			○				○	○	○
di-n-Octylphthalate	○	●	○			○				○	○	○
Dibenzo(a,h)anthracene	○	○	○			○				○	○	○
Dibenzofuran	○	○	○			○				○	○	○
Diethyl Phthalate	○	○	○			○				○	○	○
Dimethyl Phthalate	○	○	○			○				○	○	○
Fluoranthene	○	●	○			●				○	○	○
Fluorene	○	●	○			○				○	○	○
Hexachlorobenzene	○	○	○			○				○	○	○
Hexachlorobutadiene	○	○	○			○				○	○	○
Hexachlorocyclopentadiene	○	○	○			○				○	○	○
Hexachloroethane	○	○	○			○				○	○	○
Indeno(1,2,3-c,d)pyrene	○	○	○			○				○	○	○
Isophorone	○	●	○			●				○	○	○
N-Nitrosodi-n-propylamine	○	○	○			○				○	○	○
N-Nitrosodiphenylamine	○	○	○			○				○	○	○
Naphthalene	○	●	○			●				○	○	○
Nitrobenzene	○	●	○			●				○	○	○
Pentachlorophenol	○	○	○			○				○	○	○
Phenanthrene	○	●	○			●				○	○	○
Phenol	○	○	○			●				○	○	○
Pyrene	○	●	○			●				○	○	○
Miscellaneous												
Total Organic Carbon												
Gasoline Hydrocarbons						●						
AK102-Extended												
Diesel Hydrocarbons	●	●	●			●				●	●	●

○ = Non-detected ● = Detected Blanks indicate sample not analyzed.

TABLE A-4. LIST OF CHEMICALS DETECTED IN BEACH AREA

(Page 1 of 6)

Parameter	ST5				SS2			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Metals								
Aluminum						●	○	●
Antimony						○	○	○
Arsenic						●	○	○
Barium						●	●	●
Beryllium						●	○	○
Cadmium						○	○	○
Calcium				●		●	●	●
Chromium, total						●	○	●
Cobalt						●	○	●
Copper						●	●	●
Iron				●		●	●	●
Lead						●	●	●
Magnesium				●		●	●	●
Manganese						●	●	●
Mercury						●	●	●
Molybdenum						●	○	●
Nickel						●	○	●
Potassium				●		●	●	●
Selenium						●	○	○
Silica						●		
Silver							○	○
Sodium				●		●	●	●
Thallium						●	○	●
Vanadium						●	○	●
Zinc						●	●	●

TABLE A-4. LIST OF CHEMICALS DETECTED IN BEACH AREA
(Page 2 of 6)

Parameter	ST5				SS2			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Pesticides/PCBs								
4,4'-DDD		●				●	●	●
4,4'-DDE		●				●	●	●
4,4'-DDT		●				●	●	●
Aldrin		○				○	○	○
alpha BHC		○				●	○	○
alpha-Chlordane		○				○	○	○
Arochlor 1016		○				○	○	○
Arochlor 1221		○				○	○	○
Arochlor 1232		○				○	○	○
Arochlor 1242		○				○	○	○
Arochlor 1248		○				○	○	○
Arochlor 1254		○				○	○	○
Arochlor 1260		○				○	○	○
beta BHC		○				○	○	○
delta BHC		●				●	○	○
Dieldrin		○				○	○	○
Endosulfan I		○				○	○	○
Endosulfan II		○				○	○	○
Endosulfan Sulfate		○				○	○	○
Endrin		●				●	○	○
Endrin Aldehyde		○				○	○	○
gamma BHC (Lindane)		○				○	○	○
gamma-Chlordane		○				○	○	○
Heptachlor		○				○	○	○
Heptachlor Epoxide		○				○	○	○
Methoxychlor		○				○	○	○
Toxaphene		○				○	○	○

TABLE A-4. LIST OF CHEMICALS DETECTED IN BEACH AREA
(Page 3 of 6)

Parameter	ST5				SS2			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Volatile Organics								
1,1,1,2-Tetrachloroethane		○	○	○		○	○	○
1,1,1-Trichloroethane		○	○	○		○	○	○
1,1,2,2-Tetrachloroethane		○	○	○		○	○	○
1,1,2-Trichloro-1,2,2-trifluoroethane		○	○	○		○	○	○
1,1,2-Trichloroethane		○	○	○		○	○	○
1,1-Dichloroethane		○	○	○		○	○	○
1,1-Dichloroethene		○	○	○		○	○	○
1,2,3-Trichloropropane		○	○	○		○	○	○
1,2-Dichloroethane		○	○	○		○	○	○
1,2-Dichloropropane		○	○	○		○	○	○
1-Chlorohexane		○	○	○		○	○	○
2-Chloroethyl Vinyl Ether		○	○	○		○	○	○
2-Hexanone		○	○	○		○	○	○
Acetone		●	○	●		○	○	○
Benzene		○	○	○		○	○	○
Bromobenzene		○	○	○		○	○	○
Bromochloromethane		○	○	○		○	○	○
Bromodichloromethane		○	○	○		○	○	○
Bromoform		○	○	○		○	○	○
Bromomethane		○	○	○		○	○	○
Carbon Disulfide		○	○	●		○	○	○
Carbon Tetrachloride		○	○	○		○	○	○
Chlorobenzene		●	○	○		○	○	○
Chloroethane		○	○	○		○	○	○
Chloroform		○	○	○		○	○	●
Chloromethane		○	○	○		○	○	○
cis-1,2-Dichloroethylene		○	○	○		○	○	○
cis-1,3-Dichloropropene		○	○	○		○	○	○
Dibromochloromethane		○	○	○		○	○	○

TABLE A-4. LIST OF CHEMICALS DETECTED IN BEACH AREA
(Page 4 of 6)

Parameter	ST5				SS2			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Volatile Organics (Cont.)								
Ethylbenzene		●	○	●		●	○	○
m,p-xylene								
Methyl Ethyl Ketone (2-butanone)		●	○	●		○	○	○
Methyl Isobutyl Ketone		○	○	○		○	○	○
Methylene Chloride		●	○	○		●	○	○
o-xylene								
Styrene		○	○	○		○	○	○
Tetrachloroethylene (pce)		○	○	○		○	○	○
Toluene		○	○	●		○	○	○
trans-1,2-Dichloroethene		○	○	○		○	○	○
trans-1,3-Dichloropropene		○	○	○		○	○	○
Trichloroethylene (tce)		○	○	●		○	○	●
Vinyl Acetate		○	○	○		○	○	○
Vinyl Chloride		○	○	○		○	○	○
Xylenes, total		●	○	●		●	○	●
Semivolatile Organics								
1,2,4-Trichlorobenzene		○	○	○		○	○	○
1,2-Dichlorobenzene		○	○	○		○	○	○
1,3-Dichlorobenzene		○	●	●		○	●	●
1,4-Dichlorobenzene		○	○	○		○	○	○
2,2'-Oxybis (1-Chloropropane)		○	○	○		○	○	○
2,4,5-Trichlorophenol		○	○	○		○	○	○
2,4,6-Trichlorophenol		○	○	○		○	○	○
2,4-Dichlorophenol		●	○	○		○	○	○
2,4-Dimethylphenol		○	○	○		○	○	○
2,4-Dinitrophenol		○	○	○		○	○	○
2,4-Dinitrotoluene		○	○	○		○	○	○
2,6-Dinitrotoluene		○	○	○		○	○	○
2-Chloronaphthalene		○	○	○		○	○	○

TABLE A-4. LIST OF CHEMICALS DETECTED IN BEACH AREA
(Page 5 of 6)

Parameter	ST5				SS2			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Semivolatile Organics (Cont.)								
2-Chlorophenol		○	○	○		○	○	○
2-Methylnaphthalene		●	○	●		○	○	●
2-Methylphenol		○	○	○		○	○	○
2-Nitroaniline		●	○	○		○	○	○
2-Nitrophenol		●	○	○		○	○	○
3,3'-Dichlorobenzidine		○	○	○		○	○	○
3-Nitroaniline		○	○	○		○	○	○
4,6-Dinitro-2-Methylphenol		○	○	○		○	○	○
4-Bromophenyl Phenyl Ether		○	○	○		○	○	○
4-Chloro-3-Methylphenol		○	○	○		○	○	○
4-Chloroaniline		○	○	○		○	○	○
4-Chlorophenyl Phenyl Ether		○	○	○		○	○	○
4-Methylphenol		○	○	●		○	○	○
4-Nitroaniline		○	○	○		○	○	○
4-Nitrophenol		●	○	○		○	○	○
Acenaphthene		●	○	●		○	○	●
Acenaphthylene		○	○	●		○	○	○
Anthracene		○	○	○		○	○	○
Benzo(a)anthracene		○	○	○		○	○	○
Benzo(a)pyrene		○	○	○		○	○	○
Benzo(b)fluoranthene		○	○	○		○	○	○
Benzo(g,h,i)perylene		○	○	○		○	○	○
Benzo(k)fluoranthene		○	○	○		○	○	○
Benzoic Acid		○	○	●		○	○	○
Benzyl Alcohol		○	○	○		○	○	○
bis(2-Chloroethoxy) Methane		●	○	○		○	○	○
bis(2-Chloroethyl) Ether		○	○	○		○	○	○
bis(2-Ethylhexyl) Phthalate		○	○	●		○	○	●
Butylbenzylphthalate		○	○	○		○	○	○

TABLE A-4. LIST OF CHEMICALS DETECTED IN BEACH AREA
(Page 6 of 6)

Parameter	ST5				SS2			
	Sed	Soil	SW	GW	Sed	Soil	SW	GW
Semivolatle Organics (Cont.)								
Chrysene		○	○	○		○	○	○
di-n-butyl Phthalate		○	○	○		○	○	○
di-n-Octylphthalate		○	○	●		○	○	●
Dibenzo(a,h)anthracene		○	○	○		○	○	○
Dibenzofuran		●	○	●		○	○	○
Diethyl Phthalate		○	○	○		○	○	○
Dimethyl Phthalate		○	○	○		○	○	○
Fluoranthene		○	○	○		○	○	○
Fluorene		●	○	●		○	○	●
Hexachlorobenzene		○	○	○		○	○	○
Hexachlorobutadiene		○	○	○		○	○	○
Hexachlorocyclopentadiene		○	○	○		○	○	○
Hexachloroethane		○	○	○		○	○	○
Indeno(1,2,3-c,d)pyrene		○	○	○		○	○	○
Isophorone		●	○	○		○	○	○
N-Nitrosodi-n-propylamine		●	○	○		○	○	○
N-Nitrosodiphenylamine		○	○	○		○	○	○
Naphthalene		●	○	●		○	○	●
Nitrobenzene		●	○	○		○	○	○
Pentachlorophenol		○	○	○		○	○	○
Phenanthrene		●	○	●		○	○	●
Phenol		○	○	●		○	○	○
Pyrene		○	○	○		○	○	○
Miscellaneous								
Total Organic Carbon				●				●
Gasoline Hydrocarbons								
AK102-Extended						●		
Diesel Hydrocarbons		●	○	●		●	○	●

○ = Non-detected ● = Detected Blanks indicate sample not analyzed.

APPENDIX B

SCREENING FOR CHEMICALS OF POTENTIAL CONCERN

APPENDIX B

SCREENING FOR CHEMICALS OF POTENTIAL CONCERN

CONTENTS

- B-1 Risk-based Screening Concentrations for Human Health Baseline Risk Assessment
- B-2 Exposure Point Concentrations for Reasonable Maximum Exposure Scenario for Chemicals of Potential Concern, Human Health Baseline Risk Assessment
- B-3 Risk-based Screening Concentration for Ecological Baseline Risk Assessment
- B-4 Exposure Point Concentrations for Reasonable Maximum Exposure Scenario for Chemicals of Potential Concern, Ecological Baseline Risk Assessment

Table B-1. Risk-based Screening Concentrations for Human Health Baseline Risk Assessment (Page 1 of 3)

Chemical	Surface Water/Ground Water			Soil/Sediment		
	RBC ($\mu\text{g/L}$)	Endpoint	Source	RBC (mg/kg)	Endpoint	Source
Metals						
Antimony	1	NC	1	10	NC	1
Arsenic	0.05	C	1	0.04	C	1
Barium	300	NC	1	2000	NC	1
Beryllium	0.02	C	1	0.01	C	1
Cadmium	2	NC	1	10	NC	1
Chromium, total	20	NC	1			
Copper	100	NC	1	1000	NC	1
Manganese	100	NC	1	3000	NC	1
Mercury	1	NC	1			
Nickel	70	NC	1	500	NC	1
Selenium	20	NC	1	100	NC	1
Silver	20	NC	1	100	NC	1
Thallium	0.3	NC	1	2	NC	1
Vanadium	30	NC	1	200	NC	1
Zinc	1000	NC	1	8000	NC	1
Pesticides/PCBs						
4,4'-DDD	0.3	C	1	0.3	C	1
4,4'-DDE	0.2	C	1	0.2	C	1
4,4'-DDT	0.2	C	1	0.2	C	1
Aldrin	0.005	C	1	0.004	C	1
Arochlor 1016	0.01	C	1	0.008	C	1
Arochlor 1221	0.01	C	1	0.008	C	1
Arochlor 1232	0.01	C	1	0.008	C	1
Arochlor 1242	0.01	C	1	0.008	C	1
Arochlor 1248	0.01	C	1	0.008	C	1
Arochlor 1254	0.01	C	1	0.008	C	1
Arochlor 1260	0.01	C	1	0.008	C	1
Dieldrin	0.005	C	1	0.004	C	1
Endosulfan I	0.2	NC	1	1	NC	1
Endosulfan II	0.2	NC	1	1	NC	1
Endosulfan Sulfate	22	NC	4	8	NC	4
Endrin	1	NC	1	8	NC	1
Heptachlor	0.02	C	1	0.01	C	1
Heptachlor Epoxide	0.009	C	1	0.007	C	1
Methoxychlor	20	NC	1	100	NC	1
Toxaphene	0.08	C	1	0.06	C	1
alpha BHC	0.01	C	1	0.01	C	1
alpha-Chlordane	0.06	C	1	0.05	C	1
beta BHC	0.05	C	1	0.04	C	1
gamma BHC (Lindane)	0.06	C	1	0.05	C	1
gamma-Chlordane	0.06	C	1	0.05	C	1
Semi-volatile organics						
1,2,4-Trichlorobenzene	2	NC	1	300	NC	1
1,2-Dichlorobenzene	50	NC	1	2000	NC	1
1,3-Dichlorobenzene	325	NC	3	114	NC	3
1,4-Dichlorobenzene	3	C	1	3	C	1

Table B-1. Risk-based Screening Concentrations for Human Health Baseline Risk Assessment (Page 2 of 3)

Chemical	Surface Water/Ground Water			Soil/Sediment		
	RBC ($\mu\text{g/L}$)	Endpoint	Source	RBC (mg/kg)	Endpoint	Source
2,2'-Oxybis (1-Chloropropane)	0.5	C	1	0.9	C	1
2,4,5-Trichlorophenol	400	NC	1	3000	NC	1
2,4,6-Trichlorophenol	2	C	1	5	C	1
2,4-Dichlorophenol	10	NC	1	80	NC	1
2,4-Dimethylphenol	70	NC	1	500	NC	1
2,4-Dinitrophenol	7	NC	1	50	NC	1
2,4-Dinitrotoluene	0.1	C	1	0.09	C	1
2,6-Dinitrotoluene	0.1	C	1	0.09	C	1
2-Chloronaphthalene	300	NC	1	2000	NC	1
2-Chlorophenol	20	NC	1	100	NC	1
2-Methylphenol	200	NC	1	1000	NC	1
2-Nitroaniline	0.2	NC	1	2	NC	1
3,3'-Dichlorobenzidine	0.2	C	1	0.1	C	1
3-Nitroaniline	11	NC	3	4	NC	3
4-Chloroaniline	10	NC	1	100	NC	1
4-Methylphenol	200	NC	1	1000	NC	1
4-Nitroaniline	11	NC	3	4	NC	3
4-Nitrophenol	226	NC	3	80	NC	3
Acenaphthene	200	NC	1	2000	NC	1
Anthracene	1000	NC	1	8000	NC	1
Benzo(a)anthracene	0.01	C	1	0.009	C	1
Benzo(a)pyrene	0.01	C	1	0.009	C	1
Benzo(b)fluoranthene	0.01	C	1	0.009	C	1
Benzo(k)fluoranthene	0.01	C	1	0.009	C	1
Benzoic Acid	10000	NC	1	100000	NC	1
Benzyl Alcohol	1000	NC	1	8000	NC	1
Butylbenzylphthalate	700	NC	1	5000	NC	1
Chrysene	0.01	C	1	0.009	C	1
Dibenzo(a,h)anthracene	0.01	C	1	0.009	C	1
Dibenzofuran	4	NC	1	30	NC	1
Diethyl Phthalate	3000	NC	1	20000	NC	1
Dimethyl Phthalate	40000	NC	1	300000	NC	1
Fluoranthene	100	NC	1	1000	NC	1
Fluorene	100	NC	1	1000	NC	1
Hexachlorobenzene	0.05	C	1	0.04	C	1
Hexachlorobutadiene	1	C	1	0.8	C	1
Hexachlorocyclopentadiene	30	NC	1	200	NC	1
Indeno(1,2,3-c,d)pyrene	0.01	C	1	0.009	C	1
Isophorone	90	C	1	70	C	1
N-Nitrosodi-n-propylamine	0.01	C	1	0.009	C	1
N-Nitrosodiphenylamine	20	C	1	10	C	1
Naphthalene	100	NC	1	1000	NC	1
Pentachlorophenol	0.7	C	1	0.5	C	1
Phenol	2000	NC	1	20000	NC	1
Pyrene	100	NC	1	800	NC	1
bis(2-Chloroethyl) Ether	0.02	C	1	0.05	C	1
bis(2-Ethylhexyl) Phthalate	6	C	1	5	C	1

Table B-1. Risk-based Screening Concentrations for Human Health Baseline Risk Assessment (Page 3 of 3)

Chemical	Surface Water/Ground Water			Soil/Sediment		
	RBC ($\mu\text{g/L}$)	Endpoint	Source	RBC (mg/kg)	Endpoint	Source
di-n-Octylphthalate	70	NC	1	500	NC	1
di-n-butyl Phthalate	400	NC	1	3000	NC	1
<i>Volatile organics</i>						
1,1,1-Trichloroethane	200	NC	1	2000	NC	1
1,1,2,2-Tetrachloroethane	0.1	C	1	0.3	C	1
1,1,2-Trichloro-1,2,2-trifluoroetha	109500	NC	2	38556	NC	2
1,1,2-Trichloroethane	0.4	C	1	1	C	1
1,1-Dichloroethane	100	NC	1	3000	NC	1
1,1-Dichloroethene	0.08	C	1	0.1	C	1
1,2-Dichloroethane	0.3	C	1	0.7	C	1
1,2-Dichloropropane	1	C	1	0.9	C	1
Acetone	400	NC	1	3000	NC	1
Benzene	0.8	C	1	2	C	1
Bromodichloromethane	0.6	C	1	0.5	C	1
Bromoform	10	C	1	8	C	1
Bromomethane	1	NC	1	40	NC	1
Carbon Disulfide	3	NC	1	3000	NC	1
Carbon Tetrachloride	0.3	C	1	0.5	C	1
Chlorobenzene	5	NC	1	500	NC	1
Chloroethane	3000	NC	1			
Chloroform	0.4	C	1	10	C	1
Chloromethane	3	C	1	5	C	1
Dibromochloromethane	1	C	1	0.8	C	1
Ethylbenzene	200	NC	1	3000	NC	1
Hexachloroethane	6	C	1	5	C	1
Methyl Ethyl Ketone (2-butanone)	100	NC	1	1000	NC	1
Methylene Chloride	7	C	1	9	C	1
Nitrobenzene	2	NC	1	10	NC	1
Styrene	2	C	1	2	C	1
Tetrachloroethylene (pce)	2	C	1	1	C	1
Toluene	100	NC	1	5000	NC	1
Trichloroethylene (tce)	3	C	1	5	C	1
Vinyl Acetate	4000	NC	1	30000	NC	1
Vinyl Chloride	0.03	C	1	0.03	C	1
Xylenes, total	80	NC	1	50000	NC	1
cis-1,2-Dichloroethylene	40	NC	1	300	NC	1
cis-1,3-Dichloropropene	0.2	C	1	0.4	C	1
trans-1,2-Dichloroethene	70	NC	1	500	NC	1
trans-1,3-Dichloropropene	0.2	C	1	0.4	C	1

RBC = Risk-based concentration

Endpoints: C = Cancer, NC = Non-cancer

Sources:

1 = U.S. EPA (1991c) Supplemental Risk Assessment Guidance

2 = IRIS (U.S. EPA 1994c) using a route to route extrapolation and equation from U.S. EPA (1991c)

3 = U.S. EPA (1994e), Region III Risk Based Concentration Table

4 = HEAST (U.S. EPA 1994d) using RfD for endosulfan and equation from U.S. EPA (1991c)

Table B-2. Exposure Point Concentrations (EPC) for Reasonable Maximum Exposure (RME)

Scenario for Chemicals of Potential Concern

Human Health Baseline Risk Assessment (Page 1 of 5)

Media	Chemical	RME (Entire Site) Conc. Type ¹	RME (White Alice) Conc. Type ¹	RME (Beach) Conc. Type ¹	RME (East) Conc. Type ¹	RME (West) Conc. Type ¹
Ground Water	1,1,2,2-Tetrachloroethane	4.50000 P		4.50000 P		
Ground Water	1,1,2-Trichloroethane	3.50000 P		3.50000 P		
Ground Water	1,1-Dichloroethene	11.50000 P		11.50000 P		
Ground Water	1,2,4-Trichlorobenzene	1.50000 P		1.50000 P		
Ground Water	1,2-Dichloroethane	11.00000 P		11.00000 P		
Ground Water	1,2-Dichloropropane	4.00000 P		4.00000 P		
Ground Water	1,4-Dichlorobenzene	2.50000 P		2.50000 P		
Ground Water	2,2'-Oxybis (1-Chloropropane)	1.50000 P		1.50000 P		
Ground Water	2,4,6-Trichlorophenol	2.50000 P		2.50000 P		
Ground Water	2,4-Dichlorophenol	1.50000 P		1.50000 P		
Ground Water	2,4-Dinitrophenol	15.00000 P		15.00000 P		
Ground Water	2,4-Dinitrotoluene	2.00000 P		2.00000 P		
Ground Water	2,6-Dinitrotoluene	2.50000 P		2.50000 P		
Ground Water	2-Methylnaphthalene	80.11021 N		86.16000 N		
Ground Water	2-Nitroaniline	3.50000 P		3.50000 P		
Ground Water	3,3'-Dichlorobenzidine	3.50000 P		3.50000 P		
Ground Water	3-Nitroaniline	43.50000 P		43.50000 P		
Ground Water	4,4'-DDT	0.40000 M		0.40000 M		
Ground Water	4-Chloroaniline	3.00000 P		3.00000 P		
Ground Water	4-Nitroaniline	35.50000 P		35.50000 P		
Ground Water	Acenaphthylene	1.91289 N		1.98177 N		
Ground Water	Aldrin	0.01000 P		0.01000 P		
Ground Water	Arochlor 1016	0.45000 P		0.45000 P		
Ground Water	Arochlor 1221	0.40000 P		0.40000 P		
Ground Water	Arochlor 1232	0.40000 P		0.40000 P		
Ground Water	Arochlor 1242	0.35000 P		0.35000 P		
Ground Water	Arochlor 1248	0.40000 P		0.40000 P		
Ground Water	Arochlor 1254	0.50000 P		0.50000 P		
Ground Water	Arochlor 1260	0.50000 P		0.50000 P		
Ground Water	Arsenic	0.05000 P		0.05000 P		
Ground Water	Benzene	3.16216 N		3.32053 N		
Ground Water	Benzo(a)anthracene	4.50000 P		4.50000 P		
Ground Water	Benzo(a)pyrene	1.00000 P		1.00000 P		
Ground Water	Benzo(b)fluoranthene	1.00000 P		1.00000 P		
Ground Water	Benzo(k)fluoranthene	1.50000 P		1.50000 P		
Ground Water	bis(2-Chloroethyl) Ether	3.00000 P		3.00000 P		
Ground Water	bis(2-Ethylhexyl) Phthalate	2.66318 N		2.78681 N		
Ground Water	Bromodichloromethane	4.00000 P		4.00000 P		
Ground Water	Bromoform	4.00000 P		4.00000 P		
Ground Water	Bromomethane	4.00000 P		4.00000 P		
Ground Water	Carbon Disulfide	4.00000 P		4.00000 P		
Ground Water	Carbon Tetrachloride	4.00000 P		4.00000 P		
Ground Water	Chlorobenzene	3.00000 P		3.00000 P		
Ground Water	Chloroform	1.00000 M		1.00000 M		
Ground Water	Chloromethane	16.50000 P		16.50000 P		
Ground Water	Chrysene	1.00000 P		1.00000 P		
Ground Water	cis-1,3-Dichloropropene	3.00000 P		3.00000 P		
Ground Water	Dibenzo(a,h)anthracene	4.50000 P		4.50000 P		
Ground Water	Dibenzofuran	1.00000 P		1.00000 P		

Table B-2. Exposure Point Concentrations (EPC) for Reasonable Maximum Exposure (RME)

Scenario for Chemicals of Potential Concern
Human Health Baseline Risk Assessment (Page 2 of 5)

Media	Chemical	RME (Entire Site) Conc. Type ¹	RME (White Alice) Conc. Type ¹	RME (Beach) Conc. Type ¹	RME (East) Conc. Type ¹	RME (West) Conc. Type ¹
Ground Water	Dibromochloromethane	4.00000 P		4.00000 P		
Ground Water	Dieldrin	0.01000 P		0.01000 P		
Ground Water	Heptachlor Epoxide	0.00500 P		0.00500 P		
Ground Water	Hexachlorobenzene	1.00000 P		1.00000 P		
Ground Water	Hexachlorobutadiene	1.00000 P		1.00000 P		
Ground Water	Hexachlorocyclopentadiene	4.50000 P		4.50000 P		
Ground Water	Hexachloroethane	1.00000 P		1.00000 P		
Ground Water	Indeno(1,2,3-c,d)pyrene	4.00000 P		4.00000 P		
Ground Water	Manganese	0.27101 N		0.29867 N		
Ground Water	Methylene Chloride	3.50000 P		3.50000 P		
Ground Water	N-Nitrosodi-n-propylamine	2.00000 P		2.00000 P		
Ground Water	Naphthalene	88.18726 N		94.35196 N		
Ground Water	Nitrobenzene	3.50000 P		3.50000 P		
Ground Water	Pentachlorophenol	29.50000 P		29.50000 P		
Ground Water	Phenanthrene	1.91289 N		1.98177 N		
Ground Water	Styrene	2.50000 P		2.50000 P		
Ground Water	Tetrachloroethylene (pce)	2.50000 P		2.50000 P		
Ground Water	Toxaphene	0.39500 P		0.39500 P		
Ground Water	trans-1,3-Dichloropropene	4.00000 P		4.00000 P		
Ground Water	Trichloroethylene (tce)	3.00000 P		3.00000 P		
Ground Water	Vinyl Chloride	4.00000 P		4.00000 P		
Ground Water	Xylenes, total	200.48121 N		214.39756 N		
Sediment	1,1,2,2-Tetrachloroethane	0.20000 P	0.20000 P		0.00240 P	
Sediment	1,1-Dichloroethene	0.25500 P	0.25500 P		0.00300 P	0.00350 P
Sediment	2,2'-Oxybis (1-Chloropropane)	0.25000 P	0.25000 P		0.15000 P	0.10000 P
Sediment	2,4-Dinitrotoluene	0.15000 P	0.15000 P		0.10000 P	0.15000 P
Sediment	2,6-Dinitrotoluene	0.40000 P	0.40000 P		0.20000 P	0.20000 P
Sediment	3,3'-Dichlorobenzidine	0.40000 P	0.40000 P		0.30000 P	0.20000 P
Sediment	3-Nitroaniline	0.80000 P	0.80000 P		0.55000 P	0.55000 P
Sediment	4,4'-DDD	1.17505 N	1.30000 M		3.10000 M	0.01400 M
Sediment	4,4'-DDE	0.10901 N	0.28000 M		0.12000 M	0.00660 M
Sediment	4,4'-DDT	0.19018 N	0.23000 M		0.45000 M	0.00760 M
Sediment	4-Nitroaniline	0.95000 P	0.95000 P		0.65000 P	0.48500 P
Sediment	Aldrin	0.00240 P	0.00015 P		0.00240 P	0.00023 P
Sediment	alpha BHC	0.01011 N	0.00460 M		0.01700 M	0.00450 M
Sediment	Antimony	10.00000 P	5.00000 P		10.00000 P	
Sediment	Arochlor 1016	0.34500 P	0.02000 P		0.34500 P	0.03500 P
Sediment	Arochlor 1221	0.41000 P	0.02500 P		0.41000 P	0.04000 P
Sediment	Arochlor 1232	0.18000 P	0.01000 P		0.18000 P	0.01500 P
Sediment	Arochlor 1242	0.21000 P	0.01500 P		0.21000 P	0.02000 P
Sediment	Arochlor 1248	0.14000 P	0.01000 P		0.14000 P	0.01000 P
Sediment	Arochlor 1254	0.02000 M	0.02000 M			
Sediment	Arochlor 1260	0.23000 M	0.23000 M			
Sediment	Arsenic	10.00000 M				
Sediment	Benzo(a)anthracene	0.25000 P	0.25000 P		0.20000 P	0.15000 P
Sediment	Benzo(a)pyrene	0.30000 P	0.30000 P		0.20000 P	0.15000 P
Sediment	Benzo(b)fluoranthene	0.30000 P	0.30000 P		0.20000 P	0.15000 P
Sediment	Benzo(k)fluoranthene	0.55000 P	0.55000 P		0.35000 P	0.25000 P
Sediment	Beryllium	0.59736 N				

Table B-2. Exposure Point Concentrations (EPC) for Reasonable Maximum Exposure (RME)

Scenario for Chemicals of Potential Concern

Human Health Baseline Risk Assessment (Page 3 of 5)

Media	Chemical	RME (Entire Site) Conc. Type ¹	RME (White Alice) Conc. Type ¹	RME (Beach) Conc. Type ¹	RME (East) Conc. Type ¹	RME (West) Conc. Type ¹
Sediment	bis(2-Chloroethyl) Ether	0.25000 P	0.25000 P		0.20000 P	0.15000 P
Sediment	Cadmium	1.50000 P	1.00000 P		1.50000 P	
Sediment	Chrysene	0.30000 P	0.30000 P		0.20000 P	0.15000 P
Sediment	Dibenzo(a,h)anthracene	0.15000 P	0.15000 P		0.10000 P	0.10000 P
Sediment	Dieldrin	0.00475 P	0.00030 P		0.00475 P	0.00045 P
Sediment	Heptachlor	0.00345 P	0.00020 P		0.00345 P	0.00035 P
Sediment	Heptachlor Epoxide	0.01735 N			0.03300 M	0.00170 M
Sediment	Hexachlorobenzene	0.25000 P	0.25000 P		0.15000 P	0.10000 P
Sediment	Hexachlorobutadiene	0.25000 P	0.25000 P		0.15000 P	0.10000 P
Sediment	Indeno(1,2,3-c,d)pyrene	0.20000 P	0.20000 P		0.15000 P	0.10000 P
Sediment	N-Nitrosodi-n-propylamine	0.20000 P	0.20000 P		0.15000 P	0.10000 P
Sediment	Pentachlorophenol	0.23000 P	0.23000 P		0.16000 P	0.12000 P
Sediment	Selenium	10.00000 P	5.00000 P		10.00000 P	
Sediment	Thallium	19.00000 M				
Sediment	Toxaphene	0.29000 P	0.02000 P		0.29000 P	0.02500 P
Sediment	Vinyl Chloride	0.20500 P	0.20500 P		0.00250 P	0.00300 P
Soil	1,1,2,2-Tetrachloroethane	0.29500 P	0.26500 P	0.20000 P	0.29500 P	
Soil	1,1-Dichloroethene	0.50000 P	0.34000 P	0.25500 P	0.37500 P	0.50000 P
Soil	1,4-Dichlorobenzene	3.35000 P	3.35000 P	0.45000 P	0.50000 P	1.75000 P
Soil	2,2'-Oxybis (1-Chloropropane)	4.35000 P	4.35000 P	0.60000 P	0.65000 P	2.30000 P
Soil	2,4,6-Trichlorophenol	5.50000 P	5.50000 P	0.80000 P	0.85000 P	3.00000 P
Soil	2,4-Dinitrotoluene	0.20000 M			1.39496 N	0.20000 M
Soil	2,6-Dinitrotoluene	0.59061 N				0.96940 N
Soil	2-Nitroaniline	0.75915 N			1.16271 N	
Soil	3,3'-Dichlorobenzidine	7.50000 P	7.50000 P	1.05000 P	1.15000 P	4.05000 P
Soil	3-Nitroaniline	15.00000 P	15.00000 P	2.05000 P	2.20000 P	8.00000 P
Soil	4,4'-DDD	0.38215 N	0.26333 N	0.22031 N	0.68310 N	0.40194 N
Soil	4,4'-DDE	0.11283 N	0.27096 N	0.07320 N	0.12375 N	0.15052 N
Soil	4,4'-DDT	0.48682 N	1.18191 N	1.73485 N	0.18154 N	0.96436 N
Soil	4-Nitroaniline	17.50000 P	17.50000 P	2.45000 P	2.60000 P	9.50000 P
Soil	Aldrin	0.00258 N	0.00196 N		0.00137 N	0.00855 N
Soil	alpha BHC	0.00243 N	0.00606 N	0.00353 N	0.00223 N	0.00283 N
Soil	Antimony	10.00000 P	5.00000 P	5.00000 P	10.00000 P	5.00000 P
Soil	Arochlor 1016	0.90000 P	0.90000 P	0.15000 P	0.90000 P	0.90000 P
Soil	Arochlor 1221	2.10000 P	2.10000 P	0.18000 P	1.05000 P	1.05000 P
Soil	Arochlor 1232	1.05000 P	1.05000 P	0.07500 P	0.45000 P	0.45500 P
Soil	Arochlor 1242	0.90000 P	0.90000 P	0.09000 P	0.55000 P	0.55000 P
Soil	Arochlor 1248	0.90000 P	0.90000 P	0.06000 P	0.35000 P	0.41500 P
Soil	Arochlor 1254	0.03000 M	0.03000 M			
Soil	Arochlor 1260	0.48507 N	2.09926 N			0.40688 N
Soil	Arsenic	9.85638 N	10.00000 M	7.00000 M	9.41313 N	7.83885 N
Soil	Benzo(a)anthracene	0.10000 M	0.10000 M			0.05000 M
Soil	Benzo(a)pyrene	0.10000 M	0.10000 M			
Soil	Benzo(b)fluoranthene	0.10000 M	0.10000 M			
Soil	Benzo(k)fluoranthene	10.00000 P	10.00000 P	1.35000 P	1.45000 P	5.00000 P
Soil	Beryllium	0.32011 N	0.30000 M	0.10000 M	0.19469 N	0.10000 M
Soil	beta BHC	0.02795 N	0.14597 N		0.00216 N	0.00320 M
Soil	bis(2-Chloroethyl) Ether	5.00000 P	5.00000 P	0.70000 P	0.75000 P	2.75000 P
Soil	bis(2-Ethylhexyl) Phthalate	5.50000 P	5.50000 P	0.75000 P	0.80000 P	2.80000 P

Table B-2. Exposure Point Concentrations (EPC) for Reasonable Maximum Exposure (RME)

Scenario for Chemicals of Potential Concern
Human Health Baseline Risk Assessment (Page 4 of 5)

Media	Chemical	RME (Entire Site) Conc. Type ¹	RME (White Alice) Conc. Type ¹	RME (Beach) Conc. Type ¹	RME (East) Conc. Type ¹	RME (West) Conc. Type ¹
Soil	Bromodichloromethane	0.28000 P	0.19000 P	0.14500 P	0.21000 P	0.28000 P
Soil	Carbon Tetrachloride	0.42500 P	0.28500 P	0.21500 P	0.31500 P	0.42500 P
Soil	Chrysene	0.10000 M	0.10000 M			0.10000 M
Soil	cis-1,3-Dichloropropene	0.30000 P	0.20000 P	0.15500 P	0.22500 P	0.30000 P
Soil	Dibenzo(a,h)anthracene	2.95000 P	2.95000 P	0.40000 P	0.45000 P	1.55000 P
Soil	Dieldrin	0.00227 N	0.00409 N		0.00152 N	0.00280 M
Soil	Heptachlor	0.00238 N	0.00716 N		0.00125 N	0.00350 M
Soil	Heptachlor Epoxide	0.02041 N	0.00225 N		0.02108 N	0.06378 N
Soil	Hexachlorobenzene	4.35000 P	4.35000 P	0.60000 P	0.65000 P	2.30000 P
Soil	Hexachlorobutadiene	4.50000 P	4.50000 P	0.60000 P	0.65000 P	2.35000 P
Soil	Hexachloroethane	5.00000 P	5.00000 P	0.70000 P	0.75000 P	2.75000 P
Soil	Indeno(1,2,3-c,d)pyrene	3.60000 P	3.60000 P	0.50000 P	0.55000 P	1.90000 P
Soil	Isophorone	60.00000 P	60.00000 P	1.15000 P	9.50000 P	9.00000 P
Soil	N-Nitrosodi-n-propylamine	3.55000 P	3.55000 P	3.45000 P	1.80000 P	1.85000 P
Soil	N-Nitrosodiphenylamine	11.50000 P	11.50000 P	1.55000 P	1.65000 P	6.00000 P
Soil	Nitrobenzene	14.00000 P	14.00000 P	1.30000 P	1.05000 P	3.25000 P
Soil	Pentachlorophenol	4.40000 P	4.40000 P	0.60000 P	0.65000 P	2.30000 P
Soil	Thallium	13.97567 N	14.00000 M	9.00000 M	11.27400 N	11.25853 N
Soil	Toxaphene	3.35000 P	0.65000 P	0.12500 P	0.75000 P	3.35000 P
Soil	trans-1,3-Dichloropropene	0.23000 P	0.15500 P	0.12000 P	0.17000 P	0.23000 P
Soil	Vinyl Chloride	0.41000 P	0.28000 P	0.21000 P	0.30500 P	0.41000 P
Surface Water	1,1,2,2-Tetrachloroethane	1.00000 P	1.00000 P	1.00000 P	1.00000 P	
Surface Water	1,1,2-Trichloroethane	0.50000 P	0.50000 P	0.50000 P	0.50000 P	0.50000 P
Surface Water	1,1-Dichloroethene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	1,2-Dichloroethane	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	1,2-Dichloropropane	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	2,2'-Oxybis (1-Chloropropane)	0.50000 P	0.50000 P	0.50000 P	0.50000 P	0.50000 P
Surface Water	2,4,6-Trichlorophenol	2.50000 P	2.50000 P	2.50000 P	2.50000 P	2.50000 P
Surface Water	2,4-Dinitrophenol	15.00000 P	15.00000 P	15.00000 P	15.00000 P	15.00000 P
Surface Water	2,4-Dinitrotoluene	2.00000 P	2.00000 P	2.00000 P	2.00000 P	2.00000 P
Surface Water	2,6-Dinitrotoluene	2.50000 P	2.50000 P	2.50000 P	2.50000 P	2.50000 P
Surface Water	2-Nitroaniline	2.50000 P	2.00000 P	2.00000 P	2.00000 P	2.50000 P
Surface Water	3,3'-Dichlorobenzidine	3.50000 P	3.50000 P	3.50000 P	3.50000 P	3.50000 P
Surface Water	3-Nitroaniline	10.00000 P	10.00000 P	10.00000 P	10.00000 P	10.00000 P
Surface Water	4-Nitroaniline	7.00000 P	7.00000 P	5.00000 P	5.00000 P	5.00000 P
Surface Water	Aldrin	0.02243 N				0.04820 N
Surface Water	alpha BHC	0.03322 N				0.09941 N
Surface Water	Arochlor 1016	1.25000 P	0.45000 P	0.45000 P	0.45000 P	1.25000 P
Surface Water	Arochlor 1221	2.00000 P	0.40000 P	0.40000 P	0.40000 P	2.00000 P
Surface Water	Arochlor 1232	1.25000 P	0.40000 P	0.40000 P	0.40000 P	1.25000 P
Surface Water	Arochlor 1242	1.25000 P	0.35000 P	0.35000 P	0.35000 P	1.25000 P
Surface Water	Arochlor 1248	0.40000 P	0.40000 P	0.40000 P	0.40000 P	0.40000 P
Surface Water	Arochlor 1254	0.50000 P	0.50000 P	0.50000 P	0.50000 P	0.50000 P
Surface Water	Arochlor 1260	0.50000 P	0.50000 P	0.50000 P	0.50000 P	0.50000 P
Surface Water	Arsenic	0.05000 P	0.05000 P	0.05000 P	0.05000 P	
Surface Water	Benzene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Benzo(a)anthracene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Benzo(a)pyrene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Benzo(b)fluoranthene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P

Table B-2. Exposure Point Concentrations (EPC) for Reasonable Maximum Exposure (RME)

Scenario for Chemicals of Potential Concern

Human Health Baseline Risk Assessment (Page 5 of 5)

Media	Chemical	RME (Entire Site) Conc. Type ¹	RME (White Alice) Conc. Type ¹	RME (Beach) Conc. Type ¹	RME (East) Conc. Type ¹	RME (West) Conc. Type ¹
Surface Water	Benzo(k)fluoranthene	1.50000 P	1.50000 P	1.50000 P	1.50000 P	1.50000 P
Surface Water	beta BHC	0.06603 N	0.07000 M			0.16870 N
Surface Water	bis(2-Chloroethyl) Ether	3.00000 P	3.00000 P	3.00000 P	3.00000 P	3.00000 P
Surface Water	Bromodichloromethane	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Bromomethane	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Carbon Tetrachloride	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Chloroform	0.50000 P	0.50000 P	0.50000 P	0.50000 P	0.50000 P
Surface Water	Chrysene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	cis-1,3-Dichloropropene	0.50000 P	0.50000 P	0.50000 P	0.50000 P	0.50000 P
Surface Water	delta BHC	0.01742 N	0.38192 N		0.00500 P	0.00500 P
Surface Water	Dibenzo(a,h)anthracene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Dieldrin	0.01705 N				0.03000 M
Surface Water	Heptachlor	0.02086 N				0.05000 M
Surface Water	Heptachlor Epoxide	0.09237 N	0.02000 M		0.12000 M	0.24725 N
Surface Water	Hexachlorobenzene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Hexachlorobutadiene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Indeno(1,2,3-c,d)pyrene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Manganese	0.10199 N		0.02000 M	0.03000 M	
Surface Water	N-Nitrosodi-n-propylamine	2.00000 P	2.00000 P	2.00000 P	2.00000 P	2.00000 P
Surface Water	Pentachlorophenol	6.00000 P	6.00000 P	5.00000 P	5.00000 P	5.00000 P
Surface Water	Toxaphene	0.39500 P	0.39500 P	0.39500 P	0.39500 P	0.39500 P
Surface Water	trans-1,3-Dichloropropene	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P
Surface Water	Vinyl Chloride	1.00000 P	1.00000 P	1.00000 P	1.00000 P	1.00000 P

All soil and sediment data in mg/kg. Groundwater and surface water data in µg/L for organics and mg/L for metals.

Concentration Types:

P = One-half the PQL for Undetected Chemicals Which Exceeded Risk-based Screening Concentrations Based on PQLs

N = 95% UCL

M = Maximum Concentration Reported Because 95% UCL > Maximum

Table B-3. Risk-based Screening Concentration for Ecological Baseline Risk Assessment (Page 1 of 3)

Chemical	Surface Water/ Ground Water		Soil/Sediment	
	RBC ($\mu\text{g/L}$)	Source	RBC (mg/kg)	Source
Metals				
Antimony			2	4
Arsenic	190	1	6	2
Beryllium	5.3	1		
Cadmium	1.1	1	0.6	2
Chromium, total	11	1	26	2
Cobalt			50	2
Copper	12	1	16	2
Iron	1000	1	20000	2
Lead	3.2	1	31	2
Manganese			460	2
Mercury	0.012	1	0.15	4
Nickel	160	1	16	2
Selenium	5	1		
Silver	0.12	1	0.5	2
Thallium	40	1		
Zinc	110	1	120	2
Pesticides/PCBs				
4,4'-DDD	1050	1	0.002	4
4,4'-DDE	1050	1	0.002	4
4,4'-DDT	0.001	1	0.001	4
Aldrin	3	1	0.0306 ¹	3
Arochlor 1016	0.014	1	0.007	2
Arochlor 1221	0.014	1		
Arochlor 1232	0.014	1		
Arochlor 1242	0.014	1		
Arochlor 1248	0.014	1	0.03	2
Arochlor 1254	0.014	1	0.06	2
Arochlor 1260	0.014	1	0.005	2
Dieldrin	0.0019	1	0.00002	4
Endosulfan I	0.056	1	0.001194 ¹	3
Endosulfan II	0.056	1	0.001194 ¹	3
Endrin	0.0023	1	0.00002	4
Heptachlor	0.0038	1	0.001194 ¹	3
Heptachlor Epoxide	0.0038	1	0.001194 ¹	3
Methoxychlor	0.03	1	0.02388 ¹	3
Toxaphene	0.0002	1	0.000398 ¹	3
alpha-Chlordane	0.0043	1	0.00024 ¹	3
gamma BHC (Lindane)	0.08	1	0.002388 ¹	3
gamma-Chlordane	0.0043	1	0.00024 ¹	3
alpha BHC			0.002388 ¹	3
beta BHC			0.002388 ¹	3
delta BHC			0.002388 ¹	3
Semi-volatile Organics				
1,2,4-Trichlorobenzene	50	1	3.6218 ¹	3

Table B-3. Risk-based Screening Concentration for Ecological Baseline Risk Assessment (Page 2 of 3)

Chemical	Surface Water/ Ground Water		Soil/Sediment	
	RBC ($\mu\text{g/L}$)	Source	RBC (mg/kg)	Source
1,2-Dichlorobenzene	763	1	0.4776 ¹	3
1,3-Dichlorobenzene	763	1	0.4776 ¹	3
1,4-Dichlorobenzene	763	1	0.4776 ¹	3
2,4,5-Trichlorophenol	63	1		
2,4,6-Trichlorophenol	970	1		
2,4-Dichlorophenol	365	1		
2,4-Dimethylphenol	2120	1		
2,4-Dinitrophenol	150	1		
2,4-Dinitrotoluene	230	1		
2-Chloroethyl Vinyl Ether	122	1		
2-Chloronaphthalene	1600	1		
2-Chlorophenol	4380	1		
2-Methylnaphthalene			0.065	4
2-Nitrophenol	150	1		
4-Bromophenyl Phenyl Ether	122	1		
4-Chloro-3-Methylphenol	30	1		
4-Chlorophenyl Phenyl Ether	122	1		
4-Nitrophenol	150	1		
Acenaphthene	520	1	0.15	4
Anthracene			0.085	4
Benzo(a)anthracene			0.23	4
Benzo(a)pyrene			0.37	2
Benzo(b)fluoranthene			0.0517 ¹	3
Benzo(g,h,i)perylene			0.17	2
Benzo(k)fluoranthene			0.0517 ¹	3
bis(2-Ethylhexyl) Phthalate	360	1	7.9401 ¹	3
Butylbenzylphthalate	3	1		
Chrysene			0.34	2
di-n-butyl Phthalate	3	1		
di-n-Octylphthalate	3	1		
Dibenzo(a,h)anthracene			0.06	4
Diethyl Phthalate	3	1		
Dimethyl Phthalate	3	1		
Fluoranthene	3980	1	0.6	4
Fluorene			0.035	4
Hexachlorobenzene	3.68	1	0.4476 ¹	3
Hexachlorobutadiene	9.3	1	0.1592 ¹	3
Hexachlorocyclopentadiene	5.2	1	0.17512 ¹	3
Indeno(1,2,3-c,d)pyrene			0.2	2
Isophorone	117000	1		
Naphthalene	620	1	340	4
Pentachlorophenol	13	1	1.592 ¹	3
Phenanthrene	6.3	1	0.225 ¹	3
Phenol	2560	1		
Pyrene			0.35	4

Table B-3. Risk-based Screening Concentration for Ecological Baseline Risk Assessment (Page 3 of 3)

Chemical	Surface Water/ Ground Water		Soil/Sediment	
	RBC (µg/L)	Source	RBC (mg/kg)	Source
<i>Volatile Organics</i>				
1,1,1,2-Tetrachloroethane	9320	1		
1,1,1-Trichloroethane	18000	1		
1,1,2,2-Tetrachloroethane	2400	1	0.1592 ¹	3
1,1,2-Trichloroethane	9400	1	0.24676 ¹	3
1,1-Dichloroethene	11600	1	0.00398 ¹	3
1,2-Dichloroethane	20000	1	0.1194 ¹	3
1,2-Dichloropropane	5700	1		
Benzene	5300	1	0.02388 ¹	3
Carbon Tetrachloride	35200	1	0.078008 ¹	3
Chlorobenzene			0.1393 ¹	3
Chloroform	1240	1		
cis-1,2-Dichloroethylene	11600	1		
cis-1,3-Dichloropropene	244	1		
Ethylbenzene	32000	1		
Hexachloroethane	540	1		
Nitrobenzene	27000	1		
Tetrachloroethylene (pce)	840	1	0.03184 ¹	3
Toluene	17500	1		
trans-1,2-Dichloroethene	11600	1		
trans-1,3-Dichloropropene	244	1		
Trichloroethylene (tce)	21900	1	0.0796 ¹	3
Vinyl Chloride			0.0796 ¹	3
¹ Converted from original units (mg/kg OC) by using mean TOC value from Kotzebue LRRS (3.98%) RBC = Risk-based concentration Sources: 1 = U.S. EPA (1991d) Water Quality Criteria-Fresh Acute or Chronic 2 = Ontario Aquatic Sediment Quality Guidelines (Persaud et al. 1993) 3 = Sediment Criteria for New York State (Newell and Sinnott 1993) 4 = Adverse Effects to Benthic Organisms in Sediment-Effects Range-Low (Long and Morgan 1990)				

Table B-4. Exposure Point Concentrations (EPC) for Reasonable Maximum
Exposure (RME) Scenario for Chemicals of Potential Concern
Ecological Baseline Risk Assessment (Page 1 of 3)

Media	Chemical	RME (White Alice) Conc. Type ¹	RME (Beach) Conc. Type ¹	RME (East) Conc. Type ¹	RME (West) Conc. Type ¹
Ground Water	2-Methylnaphthalene		81.74500 N		
Ground Water	4,4'-DDT		0.40000 M		
Ground Water	4-Methylphenol		3.13029 N		
Ground Water	Acenaphthylene		1.98177 N		
Ground Water	Acetone		8.00000 M		
Ground Water	alpha-Chlordane		0.00500 P		
Ground Water	Arochlor 1016		0.45000 P		
Ground Water	Arochlor 1221		0.40000 P		
Ground Water	Arochlor 1232		0.40000 P		
Ground Water	Arochlor 1242		0.35000 P		
Ground Water	Arochlor 1248		0.40000 P		
Ground Water	Arochlor 1254		0.50000 P		
Ground Water	Arochlor 1260		0.50000 P		
Ground Water	Benzoic Acid		17.87262 N		
Ground Water	Cadmium		0.01000 P		
Ground Water	Carbon Disulfide		1.00000 M		
Ground Water	di-n-butyl Phthalate		7.50000 P		
Ground Water	Dibenzofuran		1.00000 M		
Ground Water	Dieldrin		0.01000 P		
Ground Water	Diethyl Phthalate		8.00000 P		
Ground Water	Endrin		0.00700 P		
Ground Water	Fluorene		2.47183 N		
Ground Water	gamma-Chlordane		0.00500 P		
Ground Water	Heptachlor		0.00500 P		
Ground Water	Heptachlor Epoxide		0.00500 P		
Ground Water	Hexachlorocyclopentadiene		23.00000 P		
Ground Water	Manganese		0.29867 N		
Ground Water	Mercury		0.00005 N		
Ground Water	Methoxychlor		0.06000 P		
Ground Water	Methyl Ethyl Ketone (2-butanone)		3.62694 N		
Ground Water	Silver		0.00200 P		
Ground Water	Toxaphene		0.39500 P		
Ground Water	Xylenes, total		214.39756 N		
Sediment	1,1,2-Trichloro-1,2,2-trifluoroethane	0.00200 M			
Sediment	1,1-Dichloroethene	0.25500 P		0.00300 P	0.00350 P
Sediment	2-Methylnaphthalene	0.25000 P		0.15000 P	0.10000 P
Sediment	4,4'-DDT	0.23000 M		0.45000 M	0.00760 M
Sediment	4-Methylphenol	0.30000 M			
Sediment	Acetone	0.03000 M			0.06000 M
Sediment	Anthracene	0.30000 P		0.20000 P	0.15000 P
Sediment	Antimony	5.00000 P		10.00000 P	
Sediment	Arochlor 1016	0.02000 P		0.34500 P	0.03500 P
Sediment	Arochlor 1260	0.23000 M			
Sediment	Benzo(b)fluoranthene	0.30000 P		0.20000 P	0.15000 P
Sediment	Benzo(g,h,i)perylene	0.25000 P		0.15000 P	0.10000 P
Sediment	Benzo(k)fluoranthene	0.55000 P		0.35000 P	0.25000 P
Sediment	Benzoic Acid			0.76000 M	
Sediment	Cadmium	1.00000 P		1.50000 P	
Sediment	Dibenzo(a,h)anthracene	0.15000 P		0.10000 P	0.10000 P
Sediment	Dieldrin				0.00100 M
Sediment	Endrin	0.01200 M		0.04300 M	

Table B-4. Exposure Point Concentrations (EPC) for Reasonable Maximum
Exposure (RME) Scenario for Chemicals of Potential Concern
Ecological Baseline Risk Assessment (Page 2 of 3)

Media	Chemical	RME (White Alice) Conc. Type ¹	RME (Beach) Conc. Type ¹	RME (East) Conc. Type ¹	RME (West) Conc. Type ¹
Sediment	Ethylbenzene	0.00120 M			
Sediment	Fluorene	0.20000 P		0.15000 P	0.10000 P
Sediment	gamma-Chlordane	0.00950 M			
Sediment	Hexachlorobutadiene	0.25000 P		0.15000 P	0.10000 P
Sediment	Methyl Ethyl Ketone (2-butanone)	0.00900 M			0.00800 M
Sediment	Methylene Chloride	0.31000 M			0.00900 M
Sediment	Silver			0.70000 M	
Sediment	Toluene	0.09900 M			
Sediment	Toxaphene	0.02000 P		0.29000 P	0.02500 P
Sediment	Xylenes, total	0.01400 M			
Soil	1,1,2-Trichloro-1,2,2-trifluoroethane	0.00200 M			
Soil	1,1-Dichloroethene	0.34000 P	0.25500 P	0.37500 P	0.50000 P
Soil	2,4-Dichlorophenol				0.10000 M
Soil	2,4-Dinitrotoluene			1.37000 N	0.48600 N
Soil	2,6-Dinitrotoluene				0.96940 N
Soil	2-Hexanone				0.70571 N
Soil	2-Methylnaphthalene	1.00000 M	16.00249 N	14.76453 N	20.96415 N
Soil	2-Nitroaniline			1.16271 N	
Soil	2-Nitrophenol				1.35900 N
Soil	4-Methylphenol	1.20000 M		0.50000 M	0.70000 M
Soil	4-Nitroaniline			0.45000 M	
Soil	4-Nitrophenol			4.10107 N	3.11928 N
Soil	Acetone	0.62929 N	0.74530 N	0.45351 N	0.97941 N
Soil	Anthracene				0.80000 M
Soil	Antimony	7.00000 M		4.00000 M	
Soil	Arochlor 1016	0.90000 P	0.15000 P	0.90000 P	0.90000 P
Soil	Arochlor 1260	2.09926 N			0.40688 N
Soil	Benzo(b)fluoranthene	0.10000 M			
Soil	Benzo(k)fluoranthene	10.00000 P	1.35000 P	1.45000 P	5.00000 P
Soil	Benzoic Acid			0.18000 M	0.32000 M
Soil	Butylbenzylphthalate			0.42867 N	
Soil	Cadmium	1.00000 P	1.00000 P	2.00000 P	1.00000 P
Soil	Chloroform			0.05136 N	
Soil	cis-1,2-Dichloroethylene			0.00200 M	0.02400 M
Soil	di-n-butyl Phthalate			0.10000 M	
Soil	Dibenzo(a,h)anthracene	2.95000 P	0.40000 P	0.45000 P	1.55000 P
Soil	Dibenzofuran		0.42178 N	0.48765 N	0.86311 N
Soil	Dieldrin	0.00409 N		0.00152 N	0.00280 M
Soil	Dimethylphthalate	0.97040 N			
Soil	Endrin	0.05424 N	0.00485 N	0.00355 N	0.01608 N
Soil	Endrin Aldehyde	0.00080 M		0.00270 M	0.00040 M
Soil	Ethylbenzene		0.19071 N	0.42952 N	2.99571 N
Soil	Fluorene	2.42434 N	0.61360 N	0.88839 N	1.11915 N
Soil	Isophorone		0.85859 N		
Soil	Lead	15.00000 M	31.00000 M	26.50831 N	10.06133 N
Soil	Methyl Ethyl Ketone (2-butanone)	0.34042 N	0.44170 N	0.26542 N	1.26735 N
Soil	Methylene Chloride	0.16460 N	0.23573 N	0.16350 N	0.28588 N
Soil	Phenol	0.20000 M		3.81915 N	0.10000 M
Soil	Toluene	0.00140 M		0.31271 N	6.75505 N
Soil	Toxaphene	0.65000 P	0.12500 P	0.75000 P	3.35000 P
Soil	Xylenes, total	0.00400 M	7.00448 N	7.27265 N	57.23661 N

Table B-4. Exposure Point Concentrations (EPC) for Reasonable Maximum
Exposure (RME) Scenario for Chemicals of Potential Concern
Ecological Baseline Risk Assessment (Page 3 of 3)

Media	Chemical	RME (White Alice) Conc. Type ¹	RME (Beach) Conc. Type ¹	RME (East) Conc. Type ¹	RME (West) Conc. Type ¹
Surface Water	4,4'-DDT				0.07479 N
Surface Water	Acetone	7.00000 M			20.93478 N
Surface Water	alpha BHC				0.09941 N
Surface Water	alpha-Chlordane	0.00500 P	0.00500 P	0.00500 P	0.00500 P
Surface Water	Arochlor 1016	0.45000 P	0.45000 P	0.45000 P	1.25000 P
Surface Water	Arochlor 1221	0.40000 P	0.40000 P	0.40000 P	2.00000 P
Surface Water	Arochlor 1232	0.40000 P	0.40000 P	0.40000 P	1.25000 P
Surface Water	Arochlor 1242	0.35000 P	0.35000 P	0.35000 P	1.25000 P
Surface Water	Arochlor 1248	0.40000 P	0.40000 P	0.40000 P	0.40000 P
Surface Water	Arochlor 1254	0.50000 P	0.50000 P	0.50000 P	0.50000 P
Surface Water	Arochlor 1260	0.50000 P	0.50000 P	0.50000 P	0.50000 P
Surface Water	Barium		0.11000 M	0.05000 M	
Surface Water	Cadmium	0.01000 P	0.01500 P	0.01500 P	
Surface Water	delta BHC	0.38192 N		0.00500 P	0.00500 P
Surface Water	Dieldrin				0.03000 M
Surface Water	Endosulfan sulfate				0.04300 N
Surface Water	Endrin	0.00700 P	0.00700 P	0.00700 P	0.00700 P
Surface Water	gamma-Chlordane	0.00500 P	0.00500 P	0.00500 P	0.00500 P
Surface Water	Heptachlor				0.05000 M
Surface Water	Heptachlor Epoxide	0.02000 M		0.12000 M	0.24725 N
Surface Water	Hexachlorocyclopentadiene	4.50000 P	4.50000 P	4.50000 P	4.50000 P
Surface Water	Magnesium		22.00000 M	3.50000 M	41.00000 M
Surface Water	Manganese		0.02000 M	0.03000 M	
Surface Water	Mercury		0.00002 M		
Surface Water	Methoxychlor	0.06000 P	0.06000 P	0.06000 P	0.06000 P
Surface Water	Methyl Ethyl Ketone (2-butanone)				1.75529 N
Surface Water	Methylene Chloride	3.00000 M			
Surface Water	Selenium	0.05000 P	0.05000 P	0.05000 P	
Surface Water	Silver	0.00200 P	0.00200 P	0.00200 P	
Surface Water	Toxaphene	0.39500 P	0.39500 P	0.39500 P	0.39500 P

All soil and sediment data in mg/kg. Groundwater and surface water data in µg/L for organics and mg/L for metals.

Concentration Types:

P = One-half the PQL for Undetected Chemicals Which Exceeded Risk-based Screening Concentrations Based on PQLs

N = 95% UCL

M = Maximum Concentration Reported Because 95% UCL > Maximum

APPENDIX C

HARVEST AND CONSUMPTION OF ANIMALS AND PLANTS IN THE KOTZEBUE VICINITY

APPENDIX C

HARVEST AND CONSUMPTION OF ANIMALS AND PLANTS IN THE KOTZEBUE VICINITY

CONTENTS

C-1 Kotzebue Average Harvest per capita

Appendix C. Kotzebue Average Harvest per capita (pounds/year), 1991

RESOURCE	POUNDS	95% CI	95% UCL	% OF TOTAL	% OF TOTAL (95% UCL)
TOTAL FISH	234.93	59.6	374.95	39.82	44.14
FISH (Salmonids)					
Salmon	75.15	52.9	114.90	12.74	13.53
Chum Salmon	73.07	52.3	111.29	12.39	13.10
Coho Salmon	0.04	147.5	0.10	0.01	0.01
Chinook Salmon	1.56	101.5	3.14	0.26	0.37
Pink Salmon	0.27	157.5	0.70	0.05	0.08
Sockeye Salmon	0.22	185.4	0.63	0.04	0.07
FISH (non-Salmonids)	159.78	66.1	265.39	27.08	31.25
Burbot	2.37	53.1	3.63	0.40	0.43
Cisco	1.19	124.7	2.67	0.20	0.31
Least Cisco	0.02	185.4	0.06	0.00	0.01
Bering Cisco	1.17	128.5	2.67	0.20	0.31
Grayling	0.28	79.7	0.50	0.05	0.06
Pike	5.14	49.6	7.69	0.87	0.91
Sheefish	116.93	76.3	206.15	19.82	24.27
Whitefish	5.48	63.3	8.95	0.93	1.05
Whitefish, Large	5.32	65.1	8.78	0.90	1.03
Whitefish, Broad/Akakik	1.13	89.6	2.14	0.19	0.25
Whitefish, Humpback	4.2	78	7.48	0.71	0.88
Unknown Whitefish	0.16	186.6	0.46	0.03	0.05
Cod	5.86	31.3	7.69	0.99	0.91
Saffron Cod	5.86	31.3	7.69	0.99	0.91
Flounder	0.32	90.3	0.61	0.05	0.07
Unknown Flounder	0.32	90.3	0.61	0.05	0.07
Halibut	0.04	187	0.11	0.01	0.01
Herring	5.86	126.4	13.27	0.99	1.56
Smelt	0.84	42.8	1.20	0.14	0.14
Unknown Smelt	0.84	42.8	1.20	0.14	0.14
Trout and Char	15.45	56.2	24.13	2.62	2.84
Char (general)	15.45	56.2	24.13	2.62	2.84
Dolly Varden	15.45	56.2	24.13	2.62	2.84
BIG GAME	176.77	30	229.80	29.96	27.06
Black bear	0.78	145.5	1.91	0.13	0.23
Brown bear	0.19	184.1	0.54	0.03	0.06
Caribou	140.98	32.3	186.52	23.90	21.96
Moose	34.59	32.3	45.76	5.86	5.39

Appendix C. Kotzebue Average Harvest per capita (pounds/year), 1991

RESOURCE	POUNDS	95% CI	95% UCL	% OF TOTAL	% OF TOTAL (95% UCL)
Sheep, wild	0.23	184.1	0.65	0.04	0.08
SMALL GAME					
Beaver	0.69	112	1.46	0.12	0.17
Hare	0.18	186.6	0.52	0.03	0.06
Artic Hare	0.4	112.9	0.85	0.07	0.10
Snowshoe Hare	0.17	121.7	0.38	0.03	0.04
Muskrat	0.23	120.4	0.51	0.04	0.06
Squirrel	0.1	148.6	0.25	0.02	0.03
Parka squirrel (ground)	0.01	186.6	0.03	0.00	0.00
	0.01	186.6	0.03	0.00	0.00
MARINE MAMMALS					
Whale	158.25	35	213.64	26.82	25.15
Belukha	4.37	89.1	8.26	0.74	0.97
Right Whale	3.54	86.4	6.60	0.60	0.78
Seal	0.83	184.9	2.36	0.14	0.28
Bearded Seal	151.32	34.7	203.83	25.65	24.00
Ringed Seal	110	33.7	147.07	18.65	17.31
Spotted Seal	18.54	68.7	31.28	3.14	3.68
Young Bearded Seal	6.74	80.9	12.19	1.14	1.44
Walrus	15.22	49.7	22.78	2.58	2.68
	2.56	137.2	6.07	0.43	0.71
BIRDS & EGGS					
Birds	3.52	44.8	5.10	0.60	0.60
Owl	3.29	46.8	4.83	0.56	0.57
Snowy Owl	0.01	186.6	0.03	0.00	0.00
Upland Game Birds	0.01	186.6	0.03	0.00	0.00
Grouse	1.53	61.9	2.48	0.26	0.29
Ptarmigan	0.02	128.3	0.05	0.00	0.01
Migratory Birds	1.51	62.5	2.45	0.26	0.29
Waterfowl	1.75	51.4	2.65	0.30	0.31
Ducks	1.63	49.1	2.43	0.28	0.29
Elder	0.98	51.6	1.49	0.17	0.17
Elder, small	0.01	186.6	0.03	0.00	0.00
Spectacled Elder	0.01	186.6	0.03	0.00	0.00
Mallard	0.48	56.1	0.75	0.08	0.09
Pintail	0.33	69.5	0.56	0.06	0.07
Ducks, unknown	0.16	66.2	0.27	0.03	0.03
Geese	0.6	60.2	0.96	0.10	0.11
Brant	0.07	116.1	0.15	0.01	0.02

Appendix C. Kotzebue Average Harvest per capita (pounds/year), 1991

RESOURCE	POUNDS	95% CI	95% UCL	% OF TOTAL	% OF TOTAL (95% UCL)
Emperor Geese	0.06	186.6	0.17	0.01	0.02
Snow Geese	0.02	187.4	0.06	0.00	0.01
Whitefronted Geese	0.12	73.1	0.21	0.02	0.02
Canada Geese (general)	0.3	66.4	0.50	0.05	0.06
Canada Geese, unknown	0.3	66.4	0.50	0.05	0.06
Whitefronted Geese	0.04	113.7	0.09	0.01	0.01
Swan	0.05	186.6	0.14	0.01	0.02
Crane	0.11	131.8	0.25	0.02	0.03
Sandhill Crane	0.11	131.8	0.25	0.02	0.03
Eggs	0.23	52.8	0.35	0.04	0.04
Seabird eggs	0.08	78.2	0.14	0.01	0.02
Murre eggs	0.01	187	0.03	0.00	0.00
Gull eggs	0.07	84.7	0.13	0.01	0.02
Unknown eggs	0.15	71.9	0.26	0.03	0.03
MARINE INVERTEBRATE					
Clams	0.14	89.1	0.26	0.02	0.03
Razor Clams	0.04	184.9	0.11	0.01	0.01
Pinkneck Clams	0.05	187.4	0.14	0.01	0.02
Unknown Clams	0.02	138.1	0.05	0.00	0.01
Crabs	0.02	138.7	0.05	0.00	0.01
King Crab	0.01	186.6	0.03	0.00	0.00
Tanner Crab	0.01	186.6	0.03	0.00	0.00
Shrimp	0.01	142.4	0.02	0.00	0.00
PLANTS & BERRIES					
Berries	15.64	20.3	18.81	2.65	2.22
Plants/Greens/Mushrooms	14.85	19.9	17.81	2.52	2.10
Unknown Greens, from land	0.79	63.7	1.29	0.13	0.15
Roots, food	0.39	60	0.62	0.07	0.07
	0.4	107.47	0.83	0.07	0.10
TOTAL	589.94		849.38	100.00	100.00

Source: "An Investigation of the Sociocultural Consequences of Outer Continental Shelf Development in Alaska," Fall and Utermohle, 1993.

APPENDIX D

CALCULATION OF NEAR-FIELD DILUTION IN KOTZEBUE SOUND

APPENDIX D.

CALCULATION OF NEAR-FIELD DILUTION IN KOTZEBUE SOUND

CONTENTS

D-1 Calculation of Near-Field Dilution at Kotzebue LRRS

CALCULATION OF NEAR-FIELD DILUTION AT KOTZEBUE LRRS

This Appendix describes the calculation of near-field dilution of groundwater in Kotzebue Sound. The estimated near-field dilution was used in this baseline risk assessment to estimate surface water chemical concentrations from measurements of groundwater chemical concentrations. Groundwater below the Kotzebue LRRS Beach Area flows west into the ocean waters of Kotzebue Sound at a rate of 17 ft/yr (5.2 m/yr), where it is subsequently diluted (USAF 1995a). The physical process of dilution can be divided into near-field and far-field components. Within the near-field component, the groundwater becomes mixed with the ocean water to such a degree that it is no longer a separate body of water. In the far-field component, additional dilution is achieved as newly mixed ocean water is transported outward to areas beyond the mixing zone.

The near-field dilution was calculated by estimating two parameters: 1) the flux of groundwater (Q_F) passing through a rectangular plane into Kotzebue Sound (m^3/yr), and 2) the flux of seawater (Q_S) moving across this plane (m^3/yr). The rectangular plane was defined by the length of the Kotzebue Beach Area (L_F), the vertical height of groundwater aquifer (H_F), and the offshore beach slope (0.00084). The near-field dilution can be calculated by the following equation:

$$\text{Dilution achieved} = \frac{Q_S + Q_F}{Q_F} \quad (\text{Equation 1})$$

Because Q_F is a very small fraction of Q_S , it can be disregarded and near-field dilution can be estimated by dividing Q_S by Q_F .

Q_F was calculated using the following equation:

$$Q_F = L_F H_F V_F \omega \quad (\text{Equation 2})$$

where, L_F is the length of the beach over which groundwater is expected to seep (823 m), H_F is the thickness of the aquifer (2.7 m), V_F is the velocity of the groundwater (5.2 m/yr), and ω is the soil porosity (0.25). All of these variables were estimated as part of the 1994 RI (USAF 1995a). Using these values, Q_F was calculated to be 2889 m³/year (8 m³/day).

Q_S can be calculated by the following equation:

$$Q_S = v A \quad (\text{Equation 3})$$

where v is the alongshore current speed and A is the area of the mixing zone. Alongshore current consists of both tidal and wind-driven components; both of these components were evaluated.

The tidal current speed, v_t , was estimated using long wave theory, which calculates water velocity at the entrance of an inlet or estuary for a long wave (e.g., a tidal wave) propagating through the inlet (U.S. ACOE 1984). Tidal current speed was calculated using following equation:

$$v_t = \frac{a}{h} c \cos wt \sin (k L_S) \quad (\text{Equation 4})$$

where, a is the tidal amplitude, h is the average water depth of Kotzebue Sound, c is the celerity of long wave, w is the tide frequency, t is time, k is the wave number, and L_S is the length of the bay. The tidal amplitude (a) was calculated as the mean tidal range (0.64 m; USAF 1995a) divided by 2, or 0.32 m. The average water depth (h) and length of the bay (L_S) were estimated as 18 m and 50 km, respectively, by examining the NOAA chart for the area (16005). The celerity of long wave (c) was calculated as the square root of g (gravity = 9.81 m/sec²) times h . This value was calculated as 13 m/sec. The tidal frequency (w) was estimated as 7.04×10^{-5} rad/sec, assuming the tide is diurnal [$2\pi/(24.8 \text{ h})(3600 \text{ s/h})$]. The wave number (k) was calculated using the equation w/c to be $5.42 \times 10^{-6} \text{ m}^{-1}$. Using the above values, equation 4 can be reduced to $v_t = 0.062 \cos wt$ m/sec. The term " $\cos wt$ " refers to the cosine wave followed by rising and falling tidal water. The average of this wave is $2/\pi$. Thus, the average current speed can be approximated by $v_t = (2/\pi) 0.062 = 0.04$ m/sec.

Wind-induced currents (i.e., waves) can be an important component of the overall current speed at a given area if they are present. To determine if currents from waves were a significant component of the overall current speed at Kotzebue, the wave height was estimated according to guidance provided in U.S. ACOE (1984). The estimation of wave height requires a wind-stress factor, U_A (adjusted wind speed) and the effective fetch distance. U_A was estimated as 6.2 m/sec, based on mean monthly wind speeds for Kotzebue from June-September and equation 3-28a from U.S. ACOE (1984). The effective fetch distance was estimated as 49,000 m by examining the NOAA chart for the area (16005). Using Figure 3-31 from U.S. ACOE (1984), the average wave height was determined to be 0.75 m. Due to the shallow nature of the beach area immediately adjacent to Kotzebue LRRS, it was predicted that waves of this size would be refracted before reaching the beach. Thus, wind-induced currents would play a relatively insignificant role in near-field dilution. The tidal current speed (0.04 m/sec) was used in Equation 3.

The second term in Equation 3 is A, the area of the mixing zone. A was calculated by the following equation:

$$A = \frac{H_F}{s} H_M \quad (\text{Equation 5})$$

where, H_F is the aquifer thickness, s is the slope of the beach, and H_M is the mixing height. The quotient H_F/s can be thought of as the width of groundwater entering the ocean. The slope of the beach was determined graphically (by examining NOAA chart 16005) to be 0.00084. The mixing height can be thought of as the average water depth for the effected area of the beach. This was determined from the NOAA chart to be 1.4 m. Using the above values, A was estimated as 4,600 m². This allowed Q_S (Equation 3) to be solved. Q_S was estimated to be 1.59×10^7 m³/day.

With estimates of both Q_F and Q_S , the simplified version of Equation 1 can be solved. The near-field dilution for groundwater in the beach area at Kotzebue LRRS was estimated as 2,000,000 ($1.59 \times 10^7/8$ m³/day).

APPENDIX E

TOXICOLOGICAL PROFILES OF DETECTED CHEMICALS OF POTENTIAL CONCERN

APPENDIX E

TOXICOLOGICAL PROFILES OF DETECTED
CHEMICALS OF POTENTIAL CONCERN

CONTENTS

E-1 TOXICOLOGICAL PROFILES ON DETECTED COPCs

APPENDIX E. TOXICOLOGICAL PROFILES ON DETECTED COPCs

2,4-Dinitrotoluene; CASRN 121-14-2

The oral RfD is $2\text{E-}3$ with an uncertainty factor of 100 based upon a factor of 10 for interspecies variability and a factor of 10 for intraspecies variability. The oral RfD is based upon a two year study in which beagle dogs were fed gelatin capsules with 2,4-Dinitrotoluene. Neurotoxic effects, characterized by incoordination and paralysis, were exhibited by all dogs at this dose level within 6 months of study initiation. Another similar study showed dogs with brain lesion characterized by gliosis, edema, and demyelination of the cerebellum, spinal cord, and brain stem. Confidence in this study is high based upon the number of animals used and the variety of gross, histological, hematologic, and clinical endpoints that were evaluated. There is inadequate data for an inhalation RfC and this substance/agent has not been evaluated by the U.S. EPA for evidence of human carcinogenic potential.

2,6-Dinitrotoluene; CASRN 606-20-2

The oral RfD is $1\text{E-}3$ with an uncertainty factor of 3000. The oral RfD is based upon a study which exposed beagle dogs orally for two years. The observed critical effects included mortality and neurotoxicity. Target organs included: whole body, central nervous system, blood, bile duct and kidney. Information obtained about this chemical is from HEAST, 1994. Carcinogenic effects have been assessed on the mixture of 2,4-Dinitrotoluene and 2,6-Dinitrotoluene. Its weight of evidence is classified as B2 based on multiple benign and malignant tumor types at multiple sites and malignant renal tumors in male mice. The classification is supported by evidence of mutagenicity. An oral slope factor of $6.8\text{E-}1$ was derived using the linearized multistage model.

2-Nitroaniline; CASRN 88-74-4

The oral RfD has been withdrawn from IRIS or HEAST and has not yet been updated. The prior value was $6\text{E-}5$, which is used for the purposed of this evaluation. The inhalation RfD is $5.71\text{E-}5$, found in HEAST, 1994. This is based upon a rodent inhalation study which observed hematological effects after four weeks of exposure.

p,p'-Dichlorodiphenyl dichloroethane (DDD); CASRN 72-54-8

There is no oral RfD or inhalation RfC. The weight of evidence for carcinogenicity is classified as B2 based on an increased incidence of lung tumors in male and female mice, liver tumors in male mice and thyroid tumors in male rats. DDD is structurally similar to, and is a known metabolite of DDT, a probable human carcinogen.

p,p'-Dichlorodiphenyldichloroethylene (DDE); CASRN 72-55-9

There is no oral RfD or inhalation RfC. The weight of evidence for carcinogenicity is classified as B2 based on an increased incidence of liver tumors including carcinomas in two strains of mice and in hamsters and of thyroid tumors in female rats by diet. DDE is structurally similar to and a metabolite of DDT which is a probable human carcinogen.

p,p'-Dichlorodiphenyltrichloroethane (DDT); CASRN 50-29-3

The oral RfD for DDT is $5E-4$ with an uncertainty factor of 100 based upon interspecies conversion and to protect sensitive human subpopulations. The oral RfD is based on a rodent study that observed liver lesions in all dose groups. There is medium confidence in the study because it is of short duration and that there lacks a clear NOEL for reproductive effects. There is inadequate data for an inhalation RfC. The weight of evidence for carcinogenicity is classified as a B2 on the basis of observations of tumors (generally of the liver) in seven studies in various mouse strains and three studies in rats. DDT is structurally similar to other probable carcinogens, such as DDD and DDE.

Aldrin; CASRN 309-00-2

The oral RfD is $3E-5$ with an uncertainty factor of 1000 based upon the uncertainty of extrapolation from animals to humans, the uncertainty in the range of human sensitivities, and an additional uncertainty because the RfD is based on a LOAEL rather than a NOAEL. The oral RfD is based upon a rodent study which observed liver and kidney lesions. The confidence is medium because it only performed histopathologic analysis and lacks other toxicologic parameters. The weight of evidence classification for carcinogenicity is classified as B2 based on studies which produced increases in tumor responses (liver carcinomas) in three different strains of mice (both sexes) upon oral administration. Tumor induction has also been observed for structurally related chemicals, including dieldrin, a metabolite.

alpha BHC; CASRN 319-84-6

There is no data available for either an oral or an inhalation RfD. The weight of evidence for carcinogenicity is classified as B2 based upon an increased incidence of liver tumors in five mouse strains and in one rat strain.

Aroclor 1254; CASRN 11097-69-1

The oral RfD is $2E-5$ with an uncertainty factor of 300 to account for sensitive individuals and a factor of 3 is applied to extrapolate from rhesus monkeys to humans. The oral RfD is based on Monkey Clinical and Immunologic Studies in which Ocular exudate, inflamed and prominent eyelid Meibomian glands, distorted fingernail and

toenail growth and decreased antibody (IgG and IgM) responses were observed. Similar changes have been documented in humans for accidental oral ingestion of PCBs. Confidence is medium due to inconsistencies in effect levels for reproductive toxicity. There is no inhalation RfC and this chemical has not been evaluated by the EPA for evidence of human carcinogenic potential. For this reason, the oral SF for PCBs was used for carcinogenic potential in this evaluation.

Aroclor 1260

Aroclor 1260 is a similar compound to Aroclor 1254. It contains Polychlorinated biphenyls congeners with chlorinated dibenzofurans (CDFs) and chlorinated dibenzodioxins (CDDs), known contaminants of PCBs, that are structurally related to and produce certain biologic effects similar to those of PCB congeners. The oral RfD and slope factor for PCB's were used for this Aroclor compound in this risk evaluation. The weight of evidence for carcinogenicity for PCB's is classified as B2 based on hepatocellular carcinomas that suggest evidence of excess risk of liver cancer to humans.

Arsenic; CASRN 7440-38-2

The oral RfD for arsenic is $3E-4$ with an uncertainty factor of 3 to account for both the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty in whether the NOAEL of the critical study accounts for all sensitive individuals. The oral RfD is based upon a human chronic oral exposure study and observed effects include: hyperpigmentation, keratosis and possible vascular complications. Confidence in the RfD is medium because the doses were not well characterized and there may have been other contaminants present. There is no inhalation RfC for arsenic. Arsenic is classified as a class A carcinogen based on observation of increased lung cancer mortality in populations exposed primarily through inhalation and on increased skin cancer incidence in several populations consuming drinking water with high arsenic concentrations. The slope factor is 1.75, although the Risk Assessment Forum is reassessing of the carcinogenicity risk associated with ingestion of inorganic arsenic. The inhalation SF is $5E+1$ based on lung cancer in humans.

Benzene; CASRN 71-43-2

The oral RfD and inhalation RfC are currently being reviewed by an EPA workgroup. The weight of evidence for carcinogenicity is classified as A based upon several studies of increased incidence of nonlymphocytic leukemia from occupational (inhalation) exposure and increased incidence of neoplasia in rats and mice exposed by inhalation and gavage. The slope factor was derived from human inhalation exposure data.

Benzo(a)anthracene; CASRN 56-55-3

The oral RfD and inhalation RfC is currently being reviewed by an EPA workgroup. The weight of evidence for carcinogenicity is classified as B2 based on the knowledge that there is no human data but sufficient data from animal bioassays which show tumor development upon exposure by: gavage, intraperitoneal, subcutaneous or intramuscular injection, and topical application. Although there are no human data that specifically link exposure to benz[a]anthracene to human cancers, benz[a]anthracene is a component of mixtures that have been associated with human cancer. These include coal tar, soots, coke oven emissions and cigarette smoke. The slope factor is derived from the Benzo(a)pyrene slope factor using a relative potency of 0.1.

Benzo(a)pyrene(BaP); CASRN 50-32-8

There is no data available for an oral RfD or an inhalation RfC. The weight of evidence for carcinogenicity is classified as B2 based upon multiple animal studies in many species demonstrating BAP to be carcinogenic following administration by numerous routes. BAP has produced positive results in numerous genotoxicity assays. However, specific human data linking benzo[a]pyrene (BAP) to a carcinogenic effect are lacking. The types of tumors in animals include: forestomach, squamous cell papillomas and carcinomas.

Benzo(b)fluoranthene; CASRN 205-99-2

There is no data available for an oral RfD or an inhalation RfC. The weight of evidence for carcinogenicity is classified as B2 based on the knowledge that there are no human data and sufficient data from animal bioassays. Benzo[b]fluoranthene produced epidermoid carcinomas and pleomorphic sarcomas tumors in mice after lung implantation, intraperitoneal (i.p.) or subcutaneous (s.c.) injection, and skin painting. The slope factor is derived from the Benzo(a)pyrene slope factor using a relative potency of 0.1.

beta BHC; CASRN 319-85-7

There is no data available for either an inhalation or oral RfD. The weight of evidence for carcinogenicity is classified as C based upon increases in benign liver tumors in one strain of mice.

Beryllium; CASRN 7440-41-7

The oral RfD is 5E-3 with an uncertainty factor of 100 to account for interspecies variation and to protect the human subpopulation. There were no adverse effects noted and a NOAEL was set at 5 ppm in drinking water using a rat chronic oral bioassay. There is low confidence in this study because only one dose level was used. There is no inhalation RfC. Beryllium is classified as a B2 carcinogen based on lung cancer in rats

and monkeys. It has an oral SF of 4.3 based on gross tumors, all sites combined. An inhalation SF is 8.4 based upon human occupational studies which demonstrated lung cancer.

bis(2-Ethylhexyl) Phthalate (DEHP); CASRN 117-81-7

The oral RfD is 2E-2 with an uncertainty factor of 1000 for interspecies variation and for protection of sensitive human subpopulations. An additional factor of 10 was used since the study's exposure time was in between chronic and subchronic time periods. The study was based on guinea pig exposure which observed significant increases in relative liver weights. The confidence is medium based on the study which used only two concentrations of DEHP. The weight of evidence for carcinogenicity is classified as B2 based upon orally administered DEHP produced significant dose-related increases in liver tumor responses in rats and mice of both sexes.

Chloroform; CASRN 67-66-3

The oral RfD is 1E-2 with an uncertainty factor of 1000 to account for the interspecies conversion, protection of sensitive human subpopulations, and concern that the effect seen was a LOAEL and not a NOEL. The oral RfD is based on a study with observed fatty cysts in livers of beagle dogs treated with Chloroform. Chloroform is considered to be highly fetotoxic, but not teratogenic. Confidence is medium because although the study was of chronic duration, used a fairly large number of dogs, and measured multiple endpoints, it only used two treatment doses and no NOEL was determined. An inhalation RfC is currently under review by an EPA workgroup. The weight of evidence for carcinogenicity is classified as B2 based on increased incidence of several tumor types (kidney epithelial tumors and hepatic carcinomas) in rats and three strains of mice.

Chrysene; CASRN 218-01-9

There is no oral RfD or inhalation RfC for Chrysene. The weight of evidence for carcinogenicity is classified as B2 based on sufficient data from animal bioassays (no human data). Chrysene produced carcinomas and malignant lymphoma in mice after intraperitoneal injection and skin carcinomas in mice following dermal exposure. The slope factor for Chrysene is derived from Benzo(a)pyrene with a relative potency of 0.001.

Dieldrin; CASRN 60-57-1

The oral RfD is 5E-5 with an uncertainty factor of 100 to allow for extrapolation from animals to humans and to account for the sensitive subpopulation. The oral RfD is based on a study which observed liver lesions (increased liver weight and liver/body weight

ratio) in rats after two years of exposure to this chemical. Confidence is medium because the study is older for which detailed data are not available and reproductive studies are lacking. The weight of evidence for carcinogenicity is classified as B2 based upon carcinogenic effects in seven strains of mice when administered orally. Dieldrin is structurally related to compounds (aldrin, chlordane, heptachlor, heptachlor epoxide, and chlorendic acid) which produce tumors in rodents.

Heptachlor; CASRN 76-44-8

The oral RfD is $5E-4$ with an uncertainty factor of 300 to account for inter- and intraspecies differences. An additional factor of 3 was considered appropriate because of the lack of chronic toxicity data in a second species. The oral RfD was based upon a 2-year rat feeding study which observed liver weight increases in males. Confidence is low due to the low quality of the study and chronic toxicity information is incomplete. The weight of evidence for carcinogenicity is classified as B2; there is inadequate human data, but sufficient evidence exist from studies in which benign and malignant liver tumors were induced in three strains of mice of both sexes. Several structurally related compounds are liver carcinogens. There is an oral slope factor and a derived inhalation slope factor.

Heptachlor Epoxide; CASRN 1024-57-3

The oral RfD is $1.3E-5$ with an uncertainty factor of 1000 to account for inter- and intraspecies differences and to account for the fact that a NOEL was not attained. The RfD is based upon a 60 week dog feeding study in which increased liver to body weight ratios in both sexes were observed. Confidence is low because the study is of low quality. The weight of evidence for carcinogenicity is classified as B2 because sufficient evidence exists from rodent studies in which liver carcinomas were induced in two strains of mice of both sexes and in CFN female rats. Several structurally related compounds are liver carcinogens. There is an oral slope factor and a derived inhalation slope factor.

Naphthalene; CASRN 91-20-3

The oral RfD is currently under review by an EPA workgroup so the old RfD of 0.04 was used for this evaluation. Naphthalene has been shown to affect the renal and hepatic systems in rodents and in study cases of humans who ingested Naphthalene (in the form of mothballs). Hemolytic anemia is the most common effect due to exposure to Naphthalene. The weight of evidence for carcinogenicity is classified as D based on no human data and inadequate data from animal bioassays.

Thallium; CASRN n/a

There is no oral RfD or SF for thallium as a metal. Thallium can be absorbed through the skin and gastrointestinal tract. An estimated lethal dose in humans is 8-12 mg/kg. Noted effects in humans include: fatty infiltration and necrosis of the liver, nephritis, gastroenteritis, pulmonary edema, and degeneration of the adrenals, peripheral and central nervous systems.

Xylenes, total; CASRN 1330-20-7

The oral RfD is $2E+0$ with an uncertainty factor of 100 to account for intra-species extrapolations and to protect sensitive subpopulations. The oral RfD is based upon a chronic rat gavage study which observed hyperactivity, decreased body weight and increased mortality. The NTP (1986) study was given a medium confidence level because it was a well-designed study in which adequately sized groups of two species were tested over a substantial portion of their lifespan, comprehensive histology was performed, and a NOAEL was defined; but clinical chemistries, blood enzymes, and urinalysis were not performed. An inhalation RfC is currently under review by an EPA workgroup. The weight of evidence for carcinogenicity is classified as D based upon Orally administered technical xylene mixtures did not result in significant increases in incidences in tumor responses in rats or mice of both sexes.

APPENDIX F

RISK ESTIMATES FOR BASELINE HUMAN HEALTH RISK ASSESSMENT

APPENDIX F

RISK ESTIMATES FOR BASELINE HUMAN HEALTH RISK ASSESSMENT

CONTENTS

- F-1 Carcinogenic and Non-Carcinogenic Risk Values for Detected COPCs at the Beach Area, Kotzebue LRRS
- F-2 Carcinogenic and Non-Carcinogenic Risk Values for Detected COPCs at the Eastern Drainage Area, Kotzebue LRRS
- F-3 Carcinogenic and Non-Carcinogenic Risk Values for Detected COPCs due to Inhalation and Ingestion of Caribou at Kotzebue LRRS
- F-4 Carcinogenic and Non-Carcinogenic Risk Values for Detected COPCs at the White Alice Area, Kotzebue LRRS
- F-5 Carcinogenic and Non-Carcinogenic Risk Values for Detected COPCs at the Western Drainage Area, Kotzebue LRRS
- F-6 Carcinogenic and Non-Carcinogenic Risk Values for Non-Detected COPCs at the Beach Area, Kotzebue LRRS
- F-7 Carcinogenic and Non-Carcinogenic Risk Values for Non-Detected COPCs at the Eastern Drainage Area, Kotzebue LRRS
- F-8 Carcinogenic and Non-Carcinogenic Risk Values for Non-Detected COPCs due to Inhalation and Ingestion of Caribou at Kotzebue LRRS
- F-9 Carcinogenic and Non-Carcinogenic Risk Values for Non-Detected COPCs at the White Alice Area, Kotzebue LRRS
- F-10 Carcinogenic and Non-Carcinogenic Risk Values for Non-Detected COPCs at the Western Drainage Area, Kotzebue LRRS

Table F-1. Carcinogenic and Non-carcinogenic Risks for Detected COPCs the Beach Area at Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Arsenic (inorganic)	Dermal Contact with Soil	7.00E+00	mg/kg				
Beryllium	Dermal Contact with Soil	1.00E-01	mg/kg				
Thallium	Dermal Contact with Soil	9.00E+00	mg/kg				
DDD (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Soil	2.20E-01	mg/kg		1.77E-08		1.09E-08
DDE (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Soil	7.30E-02	mg/kg		8.33E-09		5.13E-09
DDT (p,p'-Dichlorodiphenyl)trich	Dermal Contact with Soil	1.74E+00	mg/kg	4.53E-04	1.98E-07	8.37E-04	1.22E-07
Hexachlorocyclohexane, alpha-	Dermal Contact with Soil	4.00E-03	mg/kg		7.84E-09		4.83E-09
Manganese (water)	Dermal Contact with Surface Water	2.00E-05	mg/l				
DDT (p,p'-Dichlorodiphenyl)trich	Dermal Contact with Surface Water	2.00E-10	mg/l	1.38E-09	6.03E-13	2.55E-09	3.72E-13
Bis(2-ethylhexyl)Phthalate (DE	Dermal Contact with Surface Water	1.39E-09	mg/l	5.44E-10	1.18E-14	1.01E-09	7.30E-15
Naphthalene	Dermal Contact with Surface Water	4.72E-08	mg/l				
Benzene	Dermal Contact with Surface Water	1.66E-09	mg/l				
Chloroform	Dermal Contact with Surface Water	5.00E-10	mg/l				
Xylenes	Dermal Contact with Surface Water	1.07E-07	mg/l				
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion of Fish	9.82E-10	mg/kg	4.08E-09	1.78E-13	1.90E-08	2.77E-13
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Fish	2.86E-09	mg/kg	2.97E-10	2.14E-14	1.39E-09	3.33E-14
Naphthalene	Ingestion of Fish	1.42E-07	mg/kg	7.37E-09		3.44E-08	
Benzene	Ingestion of Fish	1.06E-09	mg/kg		1.64E-14		2.55E-14
Chloroform	Ingestion of Fish	3.90E-10	mg/kg	8.10E-11	1.27E-15	3.78E-10	1.98E-15
Xylenes	Ingestion of Fish	2.36E-07	mg/kg	2.45E-10		1.14E-09	
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion of Marine Mammals	3.15E-03	mg/kg	1.24E-02	5.42E-07	5.79E-02	8.43E-07
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Marine Mammals	4.84E-06	mg/kg	4.76E-07	3.43E-11	2.22E-06	5.34E-11
Naphthalene	Ingestion of Marine Mammals	3.23E-05	mg/kg	1.59E-06		7.42E-06	
Benzene	Ingestion of Marine Mammals	1.17E-07	mg/kg		1.72E-12		2.67E-12
Chloroform	Ingestion of Marine Mammals	2.41E-08	mg/kg	4.74E-09	7.44E-14	2.21E-08	1.16E-13
Arsenic (inorganic)	Ingestion of Soil	7.00E+00	mg/kg	1.10E-02	1.48E-06	1.02E-01	4.60E-06
Beryllium	Ingestion of Soil	1.00E-01	mg/kg	9.39E-06	5.19E-08	8.77E-05	1.62E-07
Thallium	Ingestion of Soil	9.00E+00	mg/kg				
DDD (p,p'-Dichlorodiphenyl)dich	Ingestion of Soil	2.20E-01	mg/kg		6.38E-09		1.98E-08
DDE (p,p'-Dichlorodiphenyl)dich	Ingestion of Soil	7.30E-02	mg/kg		3.00E-09		9.33E-09
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion of Soil	1.74E+00	mg/kg	1.63E-03	7.12E-08	1.52E-02	2.22E-07
Hexachlorocyclohexane, alpha-	Ingestion of Soil	4.00E-03	mg/kg		3.04E-09		9.47E-09
Manganese (water)	Ingestion Of Surface Water	2.00E-05	mg/l	1.50E-06		7.01E-06	
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion Of Surface Water	2.00E-10	mg/l	1.50E-10	6.57E-15	7.01E-10	1.02E-14
Bis(2-ethylhexyl)Phthalate (DE	Ingestion Of Surface Water	1.39E-09	mg/l	2.61E-11	1.88E-15	1.22E-10	2.92E-15
Naphthalene	Ingestion Of Surface Water	4.72E-08	mg/l	4.43E-10		2.07E-09	
Benzene	Ingestion Of Surface Water	1.66E-09	mg/l		4.65E-15		7.24E-15
Chloroform	Ingestion Of Surface Water	5.00E-10	mg/l	1.88E-11	2.95E-16	8.77E-11	4.58E-16
Xylenes	Ingestion Of Surface Water	1.07E-07	mg/l	2.01E-11		9.38E-11	
TOTAL RISK				2.55E-02	2.39E-06	1.76E-01	6.01E-06

Table F-2. Carcinogenic and Non-carcinogenic Risk Values for Detected COPCs at the East Drainage area, Kotzebue LRRS

ANALYTE	SCENARIO	EXPOSURE POINT		ADULT HAZARD		CHILD HAZARD		CHILD CANCER RISK
		CONCENTRATION	UNITS	INDEX	RISK	INDEX	RISK	
DDD (p,p'-Dichlorodiphenyl)dich	Dermal Contact With Sediment	3.10E+00	mg/kg		2.50E-07		1.54E-07	
DDE (p,p'-Dichlorodiphenyl)dich	Dermal Contact With Sediment	1.20E-01	mg/kg		1.37E-08		8.44E-09	
DDT (p,p'-Dichlorodiphenyl)trich	Dermal Contact With Sediment	4.50E-01	mg/kg	1.17E-04	5.14E-08	2.17E-04	3.16E-08	
Heptachlor Epoxide	Dermal Contact With Sediment	3.30E-02	mg/kg	4.52E-03	1.37E-07	8.35E-03	8.46E-08	
Hexachlorocyclohexane, alpha-	Dermal Contact With Sediment	1.70E-02	mg/kg		3.33E-08		2.05E-08	
Aldrin	Dermal Contact with Soil	1.00E-03	mg/kg	7.83E-05	2.57E-09	1.45E-04	1.58E-09	
Arsenic (inorganic)	Dermal Contact with Soil	9.41E+00	mg/kg					
Beryllium	Dermal Contact with Soil	1.95E-01	mg/kg					
DDD (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Soil	6.83E-01	mg/kg		5.51E-08		3.39E-08	
DDE (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Soil	1.24E-01	mg/kg		1.42E-08		8.72E-09	
DDT (p,p'-Dichlorodiphenyl)trich	Dermal Contact with Soil	1.82E-01	mg/kg	4.75E-05	2.08E-08	8.78E-05	1.28E-08	
Dieldrin	Dermal Contact with Soil	2.00E-03	mg/kg	9.39E-05	1.93E-08	1.74E-04	1.19E-08	
Dinitrotoluene, 2,4-	Dermal Contact with Soil	1.40E+00	mg/kg	1.82E-03		3.36E-03		
Heptachlor	Dermal Contact with Soil	1.00E-03	mg/kg					
Heptachlor Epoxide	Dermal Contact with Soil	2.10E-02	mg/kg	2.87E-03	8.74E-08	5.31E-03	5.39E-08	
Hexachlorocyclohexane, alpha-	Dermal Contact with Soil	2.00E-03	mg/kg		3.92E-09		2.41E-09	
Hexachlorocyclohexane, beta-	Dermal Contact with Soil	2.00E-03	mg/kg		1.20E-09		7.37E-10	
Nitroaniline, 2-	Dermal Contact with Soil	1.16E+00	mg/kg					
Thallium	Dermal Contact with Soil	1.13E+01	mg/kg					
Heptachlor Epoxide	Dermal Contact with Surface Water	1.20E-04	mg/l	8.67E-01	2.64E-05	1.60E+00	1.63E-05	
Manganese (water)	Dermal Contact with Surface Water	3.00E-05	mg/l					
Aldrin	Ingestion Of Berries	1.10E-05	mg/kg	9.67E-05	1.27E-08	4.51E-04	1.97E-08	
Dieldrin	Ingestion Of Berries	5.67E-05	mg/kg	2.99E-04	6.16E-08	1.40E-03	9.57E-08	
Dinitrotoluene, 2,4-	Ingestion Of Berries	3.89E-01	mg/kg	5.13E-02		2.39E-01		
Heptachlor	Ingestion Of Berries	1.56E-06	mg/kg	8.23E-07	4.76E-10	3.84E-06	7.41E-10	
Heptachlor Epoxide	Ingestion Of Berries	8.49E-05	mg/kg	1.72E-03	5.24E-08	8.04E-03	8.15E-08	
Hexachlorocyclohexane, alpha-	Ingestion Of Berries	4.80E-05	mg/kg		2.05E-08		3.19E-08	
Hexachlorocyclohexane, beta-	Ingestion Of Berries	4.73E-05	mg/kg		5.78E-09		8.99E-09	
Nitroaniline, 2-	Ingestion Of Berries	9.48E-01	mg/kg	4.17E+00		1.95E+01		
DDD (p,p'-Dichlorodiphenyl)dich	Ingestion Of Sediment	3.10E+00	mg/kg		1.80E-07		1.40E-07	
DDE (p,p'-Dichlorodiphenyl)dich	Ingestion Of Sediment	1.20E-01	mg/kg		9.85E-09		7.66E-09	
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion Of Sediment	4.50E-01	mg/kg	8.45E-04	3.70E-08	1.97E-03	2.87E-08	
Heptachlor Epoxide	Ingestion Of Sediment	3.30E-02	mg/kg	2.38E-03	7.25E-08	5.56E-03	5.64E-08	
Hexachlorocyclohexane, alpha-	Ingestion Of Sediment	1.70E-02	mg/kg		2.59E-08		2.01E-08	
Aldrin	Ingestion of Soil	1.00E-03	mg/kg	1.57E-05	2.05E-09	1.46E-04	6.39E-09	
Arsenic (inorganic)	Ingestion of Soil	9.41E+00	mg/kg	1.47E-02	1.99E-06	1.38E-01	6.19E-06	
Beryllium	Ingestion of Soil	1.95E-01	mg/kg	1.83E-05	1.01E-07	1.71E-04	3.15E-07	
DDD (p,p'-Dichlorodiphenyl)dich	Ingestion of Soil	6.83E-01	mg/kg		1.98E-08		6.16E-08	
DDE (p,p'-Dichlorodiphenyl)dich	Ingestion of Soil	1.24E-01	mg/kg		5.09E-09		1.58E-08	
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion of Soil	1.82E-01	mg/kg	1.71E-04	7.47E-09	1.60E-03	2.33E-08	
Dieldrin	Ingestion of Soil	2.00E-03	mg/kg	1.88E-05	3.86E-09	1.75E-04	1.20E-08	
Dinitrotoluene, 2,4-	Ingestion of Soil	1.40E+00	mg/kg	3.28E-04		3.06E-03		
Heptachlor	Ingestion of Soil	1.00E-03	mg/kg	9.39E-07	5.43E-10	8.77E-06	1.69E-09	
Heptachlor Epoxide	Ingestion of Soil	2.10E-02	mg/kg	7.59E-04	2.31E-08	7.08E-03	7.18E-08	

Table F-2. Carcinogenic and Non-carcinogenic Risk Values for Detected COPCs at the East Drainage area, Kotzebue LRRS

ANALYTE	SCENARIO	EXPOSURE POINT		ADULT HAZARD		CHILD HAZARD	
		CONCENTRATION	UNITS	INDEX	RISK	INDEX	RISK
Hexachlorocyclohexane, alpha-Hexachlorocyclohexane, beta-Nitroaniline, 2-Thallium	Ingestion of Soil	2.00E-03	mg/kg		1.52E-09		4.73E-09
	Ingestion of Soil	2.00E-03	mg/kg		4.35E-10		1.35E-09
Heptachlor Epoxide	Ingestion of Soil	1.16E+00	mg/kg	9.10E-03		8.50E-02	
	Ingestion Of Surface Water	1.13E+01	mg/kg				
Manganese (water)	Ingestion Of Surface Water	1.20E-04	mg/l	3.47E-03	1.06E-07	1.62E-02	1.64E-07
	Ingestion Of Surface Water	3.00E-05	mg/l	2.25E-06		1.05E-05	
TOTAL RISK				5.13E+00	2.98E-05	2.16E+01	2.41E-05

Table F-3. Carcinogenic and Non-carcinogenic Risk Values for Detected COPCs due to Inhalation and Ingestion of Caribou at Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Aldrin	Inhalation of Dust	3.08E-09	mg/m ³		6.35E-10		5.95E-10
Aroclor 1254	Inhalation of Dust	3.58E-08	mg/m ³				
Aroclor 1260	Inhalation of Dust	5.79E-07	mg/m ³				
Arsenic (inorganic)	Inhalation of Dust	1.18E-05	mg/m ³		2.14E-06		2.00E-06
Benzo(a)anthracene	Inhalation of Dust	1.19E-07	mg/m ³				
Benzo(a)pyrene	Inhalation of Dust	1.19E-07	mg/m ³				
Benzo(b)fluoranthene	Inhalation of Dust	1.19E-07	mg/m ³				
Beryllium	Inhalation of Dust	3.82E-07	mg/m ³		3.86E-08		3.62E-08
Chrysene	Inhalation of Dust	1.19E-07	mg/m ³				
DDD (p,p'-Dichlorodiphenyl/dich	Inhalation of Dust	4.56E-07	mg/m ³				
DDE (p,p'-Dichlorodiphenyl/dich	Inhalation of Dust	1.35E-07	mg/m ³				
DDT (p,p'-Dichlorodiphenyl/trich	Inhalation of Dust	5.81E-07	mg/m ³				
Dieldrin	Inhalation of Dust	2.71E-09	mg/m ³		2.37E-09		2.22E-09
Dinitrotoluene, 2,4-	Inhalation of Dust	2.39E-07	mg/m ³		5.25E-10		4.92E-10
Dinitrotoluene, 2,6-	Inhalation of Dust	7.05E-07	mg/m ³				
Heptachlor	Inhalation of Dust	2.83E-09	mg/m ³		1.55E-10		1.45E-10
Heptachlor Epoxide	Inhalation of Dust	2.43E-08	mg/m ³		2.66E-09		2.49E-09
Hexachlorocyclohexane, alpha-	Inhalation of Dust	2.90E-09	mg/m ³		2.20E-10		2.06E-10
Hexachlorocyclohexane, beta-	Inhalation of Dust	3.33E-08	mg/m ³		2.12E-13		1.99E-13
Nitroaniline, 2-	Inhalation of Dust	9.06E-07	mg/m ³				
Thallium	Inhalation of Dust	1.67E-05	mg/m ³				
Aldrin	Ingestion of Land Mammals	4.30E-08	mg/kg	3.59E-06	4.71E-10	1.68E-05	7.32E-10
Aroclor 1254	Ingestion of Land Mammals	7.99E-08	mg/kg	1.00E-05	3.96E-10	4.67E-05	6.16E-10
Aroclor 1260	Ingestion of Land Mammals	2.12E-07	mg/kg	7.58E-06	1.05E-09	3.54E-05	1.64E-09
Dieldrin	Ingestion of Land Mammals	2.03E-08	mg/kg	1.03E-06	2.11E-10	4.79E-06	3.29E-10
Dinitrotoluene, 2,4-	Ingestion of Land Mammals	5.10E-07	mg/kg	6.39E-07		2.98E-06	
Dinitrotoluene, 2,6-	Ingestion of Land Mammals	1.51E-06	mg/kg	3.78E-06		1.76E-05	
Heptachlor	Ingestion of Land Mammals	2.49E-07	mg/kg	1.25E-06	7.22E-10	5.82E-06	1.12E-09
Heptachlor Epoxide	Ingestion of Land Mammals	2.86E-07	mg/kg	5.51E-05	1.68E-09	2.57E-04	2.61E-09
Hexachlorocyclohexane, alpha-	Ingestion of Land Mammals	2.48E-08	mg/kg		1.01E-10		1.57E-10
Hexachlorocyclohexane, beta-	Ingestion of Land Mammals	3.46E-07	mg/kg		4.01E-10		6.24E-10
Nitroaniline, 2-	Ingestion of Land Mammals	5.52E-08	mg/kg				
Chrysene	Inhalation of Outdoor Air	1.55E-06	mg/m ³	2.30E-06		1.08E-05	
Heptachlor	Inhalation of Outdoor Air	1.01E-06	mg/m ³		5.53E-08		5.18E-08
TOTAL RISK				8.53E-05	2.24E-06	3.98E-04	2.10E-06

Table F-4. Carcinogenic and Non-carcinogenic Risk Values for Detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Aroclor 1254	Dermal Contact with Sediment	2.00E-02	mg/kg			
Aroclor 1260	Dermal Contact with Sediment	2.30E-01	mg/kg	1.78E-06	2.38E-02	1.10E-06
Arsenic (inorganic)	Dermal Contact with Sediment	5.00E+00	mg/kg			
Beryllium	Dermal Contact with Sediment	1.00E-01	mg/kg			
DDD (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Sediment	1.30E+00	mg/kg	1.05E-07		6.46E-08
DDE (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Sediment	2.80E-01	mg/kg	3.20E-08		1.97E-08
DDT (p,p'-Dichlorodiphenyl)trich	Dermal Contact with Sediment	2.30E-01	mg/kg	2.62E-08	1.11E-04	1.62E-08
Hexachlorocyclohexane, alpha-	Dermal Contact with Sediment	5.00E-03	mg/kg	9.80E-09		6.04E-09
Thallium	Dermal Contact with Sediment	1.10E+01	mg/kg			
Aldrin	Dermal Contact with Soil	2.00E-03	mg/kg	5.13E-09	2.89E-04	3.16E-09
Aroclor 1254	Dermal Contact with Soil	3.00E-02	mg/kg			
Aroclor 1260	Dermal Contact with Soil	2.10E+00	mg/kg	1.63E-05	2.17E-01	1.00E-05
Arsenic (inorganic)	Dermal Contact with Soil	1.00E+01	mg/kg			
Benzo(a)anthracene	Dermal Contact with Soil	1.00E-01	mg/kg	7.78E-08		4.79E-08
Benzo(a)pyrene	Dermal Contact with Soil	1.00E-01	mg/kg	8.27E-07		5.09E-07
Benzo(b)fluoranthene	Dermal Contact with Soil	1.00E-01	mg/kg	7.78E-08		4.79E-08
Beryllium	Dermal Contact with Soil	3.00E-01	mg/kg			
Chrysene	Dermal Contact with Soil	1.00E-01	mg/kg	7.60E-10		4.68E-10
DDD (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Soil	2.63E-01	mg/kg	2.12E-08		1.31E-08
DDE (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Soil	2.71E-01	mg/kg	3.09E-08		1.91E-08
DDT (p,p'-Dichlorodiphenyl)trich	Dermal Contact with Soil	1.18E+00	mg/kg	1.35E-07	5.70E-04	8.31E-08
Dieldrin	Dermal Contact with Soil	4.00E-03	mg/kg	3.86E-08	3.47E-04	2.38E-08
Heptachlor	Dermal Contact with Soil	7.00E-03	mg/kg			
Heptachlor Epoxide	Dermal Contact with Soil	2.00E-03	mg/kg	8.33E-09	5.06E-04	5.13E-09
Hexachlorocyclohexane, alpha-	Dermal Contact with Soil	6.00E-03	mg/kg	1.18E-08		7.24E-09
Hexachlorocyclohexane, beta-	Dermal Contact with Soil	1.46E-01	mg/kg	8.73E-08		5.38E-08
Thallium	Dermal Contact with Soil	1.40E+01	mg/kg			
Heptachlor Epoxide	Dermal Contact with Surface Water	2.00E-05	mg/l	4.40E-06	2.67E-01	2.71E-06
Hexachlorocyclohexane, beta-	Dermal Contact with Surface Water	7.00E-05	mg/l	3.05E-06		1.88E-06
Manganese (water)	Dermal Contact with Surface Water	2.70E-04	mg/l			
Aldrin	Ingestion Of Berries	1.58E-05	mg/kg	1.82E-08	6.49E-04	2.83E-08
Aroclor 1254	Ingestion Of Berries	2.97E-07	mg/kg		1.83E-05	
Aroclor 1260	Ingestion Of Berries	1.27E-06	mg/kg	6.63E-10	2.23E-05	1.03E-09
Dieldrin	Ingestion Of Berries	1.52E-04	mg/kg	1.65E-07	3.74E-03	2.57E-07
Heptachlor	Ingestion Of Berries	8.91E-06	mg/kg	2.72E-09	2.19E-05	4.23E-09
Heptachlor Epoxide	Ingestion Of Berries	9.06E-06	mg/kg	5.59E-09	8.58E-04	8.70E-09
Hexachlorocyclohexane, alpha-	Ingestion Of Berries	1.31E-04	mg/kg	5.60E-08		8.71E-08
Hexachlorocyclohexane, beta-	Ingestion Of Berries	3.20E-03	mg/kg	3.91E-07		6.08E-07
Aroclor 1254	Ingestion of Sediment	2.00E-02	mg/kg	4.70E-04	4.38E-03	
Aroclor 1260	Ingestion of Sediment	2.30E-01	mg/kg	2.14E-07	1.44E-02	6.65E-07
Arsenic (inorganic)	Ingestion of Sediment	5.00E+00	mg/kg	1.06E-06	7.31E-02	3.29E-06
Beryllium	Ingestion of Sediment	1.00E-01	mg/kg	5.19E-08	8.77E-05	1.62E-07
DDD (p,p'-Dichlorodiphenyl)dich	Ingestion of Sediment	1.30E+00	mg/kg	3.77E-08		1.17E-07
DDE (p,p'-Dichlorodiphenyl)dich	Ingestion of Sediment	2.80E-01	mg/kg	1.15E-08		3.58E-08
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion of Sediment	2.30E-01	mg/kg	9.44E-09	2.02E-03	2.94E-08
Hexachlorocyclohexane, alpha-	Ingestion of Sediment	5.00E-03	mg/kg	3.80E-09		1.18E-08

Table F-4. Carcinogenic and Non-carcinogenic Risk Values for Detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Thallium	Ingestion of Sediment	1.10E+01				
Aldrin	Ingestion of Soil	2.00E-03	3.13E-05	4.11E-09	2.92E-04	1.28E-08
Aroclor 1254	Ingestion of Soil	3.00E-02	7.05E-04		6.58E-03	
Aroclor 1260	Ingestion of Soil	2.10E+00	1.41E-02	1.95E-06	1.31E-01	6.07E-06
Arsenic (inorganic)	Ingestion of Soil	1.00E+01	1.57E-02	2.11E-06	1.46E-01	6.58E-06
Benzo(a)anthracene	Ingestion of Soil	1.00E-01		8.82E-09		2.74E-08
Benzo(a)pyrene	Ingestion of Soil	1.00E-01		8.82E-09		2.74E-07
Benzo(b)fluoranthene	Ingestion of Soil	1.00E-01		8.82E-09		2.74E-08
Beryllium	Ingestion of Soil	3.00E-01	2.82E-05	1.56E-07	2.63E-04	4.85E-07
Chrysene	Ingestion of Soil	1.00E-01		8.82E-11		2.74E-10
DDD (p,p'-Dichlorodiphenyldich	Ingestion of Soil	2.63E-01		7.62E-09		2.37E-08
DDE (p,p'-Dichlorodiphenyldich	Ingestion of Soil	2.71E-01		1.11E-08		3.46E-08
DDT (p,p'-Dichlorodiphenyltrich	Ingestion of Soil	1.18E+00		4.85E-08	1.04E-02	1.51E-07
Dieldrin	Ingestion of Soil	4.00E-03	3.76E-05	7.73E-09	3.51E-04	2.40E-08
Heptachlor	Ingestion of Soil	7.00E-03	6.58E-06	3.80E-09	6.14E-05	1.18E-08
Heptachlor Epoxide	Ingestion of Soil	2.00E-03	7.23E-05	2.20E-09	6.74E-04	6.84E-09
Hexachlorocyclohexane, alpha-	Ingestion of Soil	6.00E-03		4.57E-09		1.42E-08
Hexachlorocyclohexane, beta-	Ingestion of Soil	1.46E-01		3.17E-08		9.87E-08
Thallium	Ingestion of Soil	1.40E+01				
Heptachlor Epoxide	Ingestion of Surface Water	2.00E-05	5.78E-04	1.76E-08	2.70E-03	2.74E-08
Hexachlorocyclohexane, beta-	Ingestion of Surface Water	7.00E-05		1.22E-08		1.89E-08
Manganese (water)	Ingestion of Surface Water	2.70E-04	2.03E-05		9.47E-05	
TOTAL RISK			3.19E-01	3.35E-05	9.08E-01	3.58E-05

Table F-5. Carcinogenic and Non-carcinogenic Risk Values for Detected COPCs at the West Drainage area, Kozzebug LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	ADULT HAZARD INDEX	ADULT HAZARD RISK	CHILD HAZARD INDEX	CHILD HAZARD RISK
Aldrin	Ingestion of Berries	6.89E-05	mg/kg 6.06E-04	7.95E-08	2.83E-03	1.24E-07
Aroclor 1260	Ingestion of Berries	2.46E-07	mg/kg 9.27E-07	1.29E-10	4.33E-06	2.00E-10
Dieldrin	Ingestion of Berries	1.04E-04	mg/kg 5.49E-04	1.13E-07	2.56E-03	1.76E-07
Dinitrotoluene, 2,4-	Ingestion of Berries	5.58E-02	mg/kg 7.36E-03		3.44E-02	
Dinitrotoluene, 2,6-	Ingestion of Berries	2.71E-01	mg/kg 7.15E-02		3.34E-01	
Heptachlor	Ingestion of Berries	4.35E-06	mg/kg 2.30E-06	1.33E-09	1.07E-05	2.07E-09
Heptachlor Epoxide	Ingestion of Berries	2.57E-04	mg/kg 5.22E-03	1.59E-07	2.43E-02	2.47E-07
Hexachlorocyclohexane, alpha-	Ingestion of Berries	6.10E-05	mg/kg	2.61E-08		4.06E-08
Hexachlorocyclohexane, beta-	Ingestion of Berries	7.02E-05	mg/kg	8.57E-09	1.33E-08	1.33E-08
DDD (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Sediment	1.40E-02	mg/kg	1.13E-09	6.95E-10	6.95E-10
DDE (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Sediment	7.00E-03	mg/kg	7.99E-10	4.92E-10	4.92E-10
DDT (p,p'-Dichlorodiphenyl)trich	Dermal Contact with Sediment	8.00E-03	mg/kg 2.09E-06	9.13E-10	3.86E-06	5.62E-10
Heptachlor Epoxide	Dermal Contact with Sediment	2.00E-03	mg/kg 2.74E-04	8.33E-09	5.06E-04	5.13E-09
Hexachlorocyclohexane, alpha-	Dermal Contact with Sediment	5.00E-03	mg/kg	9.80E-09		6.04E-09
DDD (p,p'-Dichlorodiphenyl)dich	Ingestion of Sediment	1.40E-02	mg/kg	4.06E-10		1.26E-09
DDE (p,p'-Dichlorodiphenyl)dich	Ingestion of Sediment	7.00E-03	mg/kg	2.87E-10		8.94E-10
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion of Sediment	8.00E-03	mg/kg 7.51E-06	3.28E-10	7.01E-05	1.02E-09
Heptachlor Epoxide	Ingestion of Sediment	2.00E-03	mg/kg 7.23E-05	2.20E-09	6.74E-04	6.84E-09
Hexachlorocyclohexane, alpha-	Ingestion of Sediment	5.00E-03	mg/kg	3.80E-09		1.18E-08
Aldrin	Dermal Contact with Soil	9.00E-03	mg/kg 7.05E-04	2.31E-08	1.30E-03	1.42E-08
Aroclor 1260	Dermal Contact with Soil	4.07E-01	mg/kg 2.28E-02	3.16E-06	4.21E-02	1.94E-06
Arsenic (inorganic)	Dermal Contact with Soil	7.84E+00	mg/kg			
Benzo(a)anthracene	Dermal Contact with Soil	5.00E-02	mg/kg	3.89E-08		2.40E-08
Beryllium	Dermal Contact with Soil	1.00E-01	mg/kg			
Chrysene	Dermal Contact with Soil	1.00E-01	mg/kg	7.60E-10		4.68E-10
DDD (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Soil	4.02E-01	mg/kg	3.24E-08		2.00E-08
DDE (p,p'-Dichlorodiphenyl)dich	Dermal Contact with Soil	1.51E-01	mg/kg	1.72E-08		1.06E-08
DDT (p,p'-Dichlorodiphenyl)trich	Dermal Contact with Soil	9.64E-01	mg/kg 2.52E-04	1.10E-07	4.65E-04	6.78E-08
Dieldrin	Dermal Contact with Soil	3.00E-03	mg/kg 1.41E-04	2.90E-08	2.60E-04	1.79E-08
Dinitrotoluene, 2,4-	Dermal Contact with Soil	2.00E-01	mg/kg 2.61E-04		4.82E-04	
Dinitrotoluene, 2,6-	Dermal Contact with Soil	9.69E-01	mg/kg			
Heptachlor	Dermal Contact with Soil	4.00E-03	mg/kg			
Heptachlor Epoxide	Dermal Contact with Soil	6.40E-02	mg/kg 8.76E-03	2.66E-07	1.62E-02	1.64E-07
Hexachlorocyclohexane, alpha-	Dermal Contact with Soil	3.00E-03	mg/kg	5.88E-09		3.62E-09
Hexachlorocyclohexane, beta-	Dermal Contact with Soil	3.00E-03	mg/kg	1.79E-09		1.10E-09
Thallium	Dermal Contact with Soil	1.13E+01	mg/kg			
Aldrin	Ingestion of Soil	9.00E-03	mg/kg 1.41E-04	1.85E-08	1.32E-03	5.75E-08
Aroclor 1260	Ingestion of Soil	4.07E-01	mg/kg 2.73E-03	3.78E-07	2.55E-02	1.18E-06
Arsenic (inorganic)	Ingestion of Soil	7.84E+00	mg/kg 1.23E-02	1.66E-06	1.15E-01	5.15E-06
Benzo(a)anthracene	Ingestion of Soil	5.00E-02	mg/kg	4.41E-09		1.37E-08
Beryllium	Ingestion of Soil	1.00E-01	mg/kg 9.39E-06	5.19E-08	8.77E-05	1.62E-07
Chrysene	Ingestion of Soil	1.00E-01	mg/kg	8.82E-11		2.74E-10
DDD (p,p'-Dichlorodiphenyl)dich	Ingestion of Soil	4.02E-01	mg/kg	1.17E-08		3.63E-08
DDE (p,p'-Dichlorodiphenyl)dich	Ingestion of Soil	1.51E-01	mg/kg	6.20E-09		1.93E-08
DDT (p,p'-Dichlorodiphenyl)trich	Ingestion of Soil	9.64E-01	mg/kg 9.06E-04	3.96E-08	8.45E-03	1.23E-07
Dieldrin	Ingestion of Soil	3.00E-03	mg/kg 2.82E-05	5.80E-09	2.63E-04	1.80E-08

Table F-5. Carcinogenic and Non-carcinogenic Risk Values for Detected COPCs at the West Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION UNITS	ADULT HAZARD INDEX	ADULT HAZARD RISK	CHILD HAZARD INDEX	CHILD HAZARD RISK
Dinitrotoluene, 2,4-	Ingestion of Soil	2.00E-01	4.70E-05		4.38E-04	
Dinitrotoluene, 2,6-	Ingestion of Soil	9.69E-01	4.55E-04		4.25E-03	
Heptachlor	Ingestion of Soil	4.00E-03	3.76E-06	2.17E-09	3.51E-05	6.76E-09
Heptachlor Epoxide	Ingestion of Soil	6.40E-02	2.31E-03	7.03E-08	2.16E-02	2.19E-07
Hexachlorocyclohexane, alpha-	Ingestion of Soil	3.00E-03		2.28E-09		7.10E-09
Hexachlorocyclohexane, beta-	Ingestion of Soil	3.00E-03		6.52E-10		2.03E-09
Thallium	Ingestion of Soil	1.13E+01				
Aldrin	Dermal Contact with Surface Water	4.80E-05	4.81E-04	1.58E-08	8.90E-04	9.73E-09
Dieldrin	Dermal Contact with Surface Water	3.00E-05	1.80E-03	3.71E-07	3.34E-03	2.29E-07
Heptachlor	Dermal Contact with Surface Water	5.00E-05				
Heptachlor Epoxide	Dermal Contact with Surface Water	2.47E-04	1.78E+00	5.43E-05	3.30E+00	3.35E-05
Hexachlorocyclohexane, alpha-	Dermal Contact with Surface Water	9.90E-05		2.48E-07		1.53E-07
Hexachlorocyclohexane, beta-	Dermal Contact with Surface Water	1.69E-04		1.29E-07		7.98E-08
Aldrin	Ingestion of Surface Water	4.80E-05	6.01E-04	7.88E-08	2.81E-03	1.23E-07
Dieldrin	Ingestion of Surface Water	3.00E-05	2.25E-04	4.64E-08	1.05E-03	7.21E-08
Heptachlor	Ingestion of Surface Water	5.00E-05	3.76E-05	2.17E-08	1.75E-04	3.38E-08
Heptachlor Epoxide	Ingestion of Surface Water	2.47E-04	7.14E-03	2.17E-07	3.33E-02	3.38E-07
Hexachlorocyclohexane, alpha-	Ingestion of Surface Water	9.90E-05		6.03E-08		9.37E-08
Hexachlorocyclohexane, beta-	Ingestion of Surface Water	1.69E-04		2.94E-08		4.57E-08
TOTAL RISK			1.93E+00	6.19E-05	3.98E+00	4.46E-05

Table F-6. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Beach area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Aldrin	Ingestion of Fish	2.02E-11	mg/kg	1.40E-09	1.83E-13	6.53E-09	2.85E-13
Aroclor 1016	Ingestion of Fish	1.04E-09	mg/kg	3.09E-08		1.44E-07	
Aroclor 1221	Ingestion of Fish	8.28E-10	mg/kg	2.46E-08	3.41E-12	1.15E-07	5.30E-12
Aroclor 1232	Ingestion of Fish	9.38E-10	mg/kg	2.78E-08	3.86E-12	1.30E-07	6.00E-12
Aroclor 1248	Ingestion of Fish	1.13E-09	mg/kg	3.35E-08	4.65E-12	1.56E-07	7.23E-12
Aroclor 1254	Ingestion of Fish	1.42E-09	mg/kg	1.47E-07		6.88E-07	
Aroclor 1260	Ingestion of Fish	1.39E-09	mg/kg	4.12E-08	5.72E-12	1.92E-07	8.89E-12
Aroclor-1242	Ingestion of Fish	8.10E-10	mg/kg				
Benzo(a)anthracene	Ingestion of Fish	9.09E-09	mg/kg		3.54E-12		5.51E-12
Benzo(a)pyrene	Ingestion of Fish	1.48E-09	mg/kg		5.77E-12		8.98E-12
Benzo(b)fluoranthene	Ingestion of Fish	3.25E-09	mg/kg		1.27E-12		1.97E-12
Benzo(k)fluoranthene	Ingestion of Fish	3.73E-09	mg/kg		1.45E-13		2.26E-13
Bis(Chloroethyl)ether	Ingestion of Fish	1.56E-09	mg/kg		9.17E-13		1.43E-12
Bromodichloromethane	Ingestion of Fish	2.74E-09	mg/kg	2.85E-10	9.07E-14	1.33E-09	1.41E-13
Bromoform	Ingestion of Fish	3.14E-09	mg/kg	3.26E-10	1.32E-14	1.52E-09	2.06E-14
Bromomethane	Ingestion of Fish	9.40E-10	mg/kg	1.39E-09		6.51E-09	
Carbon Disulfide	Ingestion of Fish	1.80E-09	mg/kg	3.74E-11		1.74E-10	
Carbon Tetrachloride	Ingestion of Fish	2.48E-09	mg/kg	7.36E-09	1.72E-13	3.43E-08	2.68E-13
Chloroaniline, 4-	Ingestion of Fish	1.95E-09	mg/kg	1.01E-09		4.73E-09	
Chlorobenzene	Ingestion of Fish	3.63E-09	mg/kg	3.77E-10		1.76E-09	
Chrysene	Ingestion of Fish	2.13E-09	mg/kg		8.31E-15		1.29E-14
Dibenz(a,h)anthracene	Ingestion of Fish	1.06E-08	mg/kg		4.13E-11		6.43E-11
Dibenzofuran	Ingestion of Fish	1.62E-09	mg/kg	8.41E-10		3.93E-09	
Dibromochloromethane	Ingestion of Fish	2.94E-09	mg/kg	3.05E-10	1.32E-13	1.42E-09	2.05E-13
Dichlorobenzene, 1,4-	Ingestion of Fish	3.58E-09	mg/kg		4.59E-14		7.14E-14
Dichlorobenzidine, 3,3'	Ingestion of Fish	1.07E-08	mg/kg		2.57E-12		4.00E-12
Dichloromethane	Ingestion of Fish	1.23E-09	mg/kg	4.26E-11	4.93E-15	1.99E-10	7.66E-15
Dichlorophenol, 2,4-	Ingestion of Fish	1.50E-09	mg/kg	1.04E-09		4.85E-09	
Dichloropropane, 1,2-	Ingestion of Fish	2.52E-09	mg/kg		9.15E-14		1.42E-13
Dichloropropene, Cis-1,3-	Ingestion of Fish	7.26E-09	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Fish	9.68E-09	mg/kg				
Dieldrin	Ingestion of Fish	1.89E-11	mg/kg	7.85E-10	1.62E-13	3.66E-09	2.51E-13
Dinitrophenol, 2,4-	Ingestion of Fish	6.83E-09	mg/kg	7.09E-09		3.31E-08	
Dinitrotoluene, 2,4-	Ingestion of Fish	2.31E-09	mg/kg	2.40E-09		1.12E-08	
Dinitrotoluene, 2,6-	Ingestion of Fish	1.35E-09	mg/kg	2.80E-09		1.31E-08	
Heptachlor Epoxide	Ingestion of Fish	1.04E-11	mg/kg	1.66E-09	5.05E-14	7.75E-09	7.86E-14
Hexachlorobenzene	Ingestion of Fish	2.00E-09	mg/kg	5.19E-09	1.71E-12	2.42E-08	2.66E-12
Hexachlorobutadiene	Ingestion of Fish	1.88E-09	mg/kg		7.83E-14		1.22E-13

Table F-6. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Beach area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Hexachlorocyclopentadiene	Ingestion of Fish	5.96E-09	mg/kg	1.77E-09		8.25E-09	
Hexachloroethane	Ingestion of Fish	1.35E-09	mg/kg	2.80E-09	1.01E-14	1.31E-08	1.57E-14
Nitroaniline, 2-	Ingestion of Fish	2.07E-09	mg/kg	7.17E-08		3.34E-07	
Nitroaniline, 3-	Ingestion of Fish	1.76E-08	mg/kg	1.22E-08		5.69E-08	
Nitroaniline, 4-	Ingestion of Fish	2.24E-08	mg/kg	1.55E-08		7.24E-08	
Nitrobenzene	Ingestion of Fish	2.07E-09	mg/kg	8.60E-09		4.01E-08	
Nitrosodi-N-propylamine, N-	Ingestion of Fish	1.78E-09	mg/kg		6.66E-12		1.04E-11
Pentachlorophenol	Ingestion of Fish	5.50E-08	mg/kg	3.81E-09	3.53E-12	1.78E-08	5.48E-12
Tetrachloroethane, 1,1,2,2-	Ingestion of Fish	2.25E-09	mg/kg		2.40E-13		3.74E-13
Tetrachloroethylene	Ingestion of Fish	2.65E-09	mg/kg	5.50E-10		2.57E-09	
Toxaphene	Ingestion of Fish	9.46E-10	mg/kg		5.56E-13		8.65E-13
Trichlorobenzene, 1,2,4-	Ingestion of Fish	2.34E-09	mg/kg	4.86E-10		2.27E-09	
Trichloroethylene	Ingestion of Fish	2.93E-09	mg/kg	1.01E-09		4.73E-09	
Trichlorophenol, 2,4,6-	Ingestion of Fish	3.11E-09	mg/kg		1.83E-14		2.84E-14
Vinyl Chloride	Ingestion of Fish	1.40E-08	mg/kg		1.42E-11		2.21E-11
Aldrin	Ingestion of Marine Mammals	2.08E-08	mg/kg	1.36E-06	1.79E-10	6.37E-06	2.78E-10
Aroclor 1016	Ingestion of Marine Mammals	7.10E-04	mg/kg	2.00E-02		9.32E-02	
Aroclor 1221	Ingestion of Marine Mammals	4.39E-07	mg/kg	1.23E-05	1.71E-09	5.76E-05	2.66E-09
Aroclor 1232	Ingestion of Marine Mammals	1.26E-06	mg/kg	3.54E-05	4.91E-09	1.65E-04	7.64E-09
Aroclor 1254	Ingestion of Marine Mammals	5.00E-03	mg/kg	4.92E-01		2.30E+00	
Aroclor 1260	Ingestion of Marine Mammals	1.09E-02	mg/kg	3.07E-01	4.25E-05	1.43E+00	6.61E-05
Aroclor-1242	Ingestion of Marine Mammals	9.79E-04	mg/kg				
Benzo(a)anthracene	Ingestion of Marine Mammals	1.48E-03	mg/kg		5.47E-07		8.51E-07
Benzo(a)pyrene	Ingestion of Marine Mammals	2.70E-03	mg/kg		9.98E-06		1.55E-05
Benzo(b)fluoranthene	Ingestion of Marine Mammals	1.18E-02	mg/kg		4.36E-06		6.78E-06
Benzo(k)fluoranthene	Ingestion of Marine Mammals	2.94E-02	mg/kg		1.09E-06		1.69E-06
Bis(Chloroethyl)ether	Ingestion of Marine Mammals	1.75E-08	mg/kg		9.74E-12		1.52E-11
Bromoform	Ingestion of Marine Mammals	1.99E-07	mg/kg	1.96E-08	7.96E-13	9.14E-08	1.24E-12
Bromomethane	Ingestion of Marine Mammals	1.87E-08	mg/kg	2.63E-08		1.23E-07	
Chlorobenzene	Ingestion of Marine Mammals	2.25E-06	mg/kg	2.21E-07		1.03E-06	
Chloromethane	Ingestion of Marine Mammals	6.44E-08	mg/kg				
Chrysene	Ingestion of Marine Mammals	3.29E-04	mg/kg		1.22E-09		1.89E-09
Dibenz(a,h)anthracene	Ingestion of Marine Mammals	4.66E-02	mg/kg		1.72E-04		2.68E-04
Dichlorobenzene, 1,4-	Ingestion of Marine Mammals	1.15E-06	mg/kg		1.40E-11		2.17E-11
Dichlorobenzidine, 3,3'	Ingestion of Marine Mammals	1.08E-06	mg/kg		2.46E-10		3.83E-10
Dichloroethane, 1,2-	Ingestion of Marine Mammals	1.17E-07	mg/kg		5.39E-12		8.38E-12
Dichloroethene, 1,1-	Ingestion of Marine Mammals	1.29E-07	mg/kg	2.82E-08	3.92E-11	1.32E-07	6.09E-11
Dichloromethane	Ingestion of Marine Mammals	2.83E-08	mg/kg	9.29E-10	1.07E-13	4.33E-09	1.67E-13

Table F-6. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Beach area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Dichlorophenol, 2,4-	Ingestion of Marine Mammals	3.09E-07	mg/kg	2.03E-07		9.46E-07	
Dichloropropane, 1,2-	Ingestion of Marine Mammals	1.92E-07	mg/kg		6.61E-12		1.03E-11
Dichloropropene, Cis-1,3-	Ingestion of Marine Mammals	8.35E-08	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Marine Mammals	1.11E-07	mg/kg				
Dieldrin	Ingestion of Marine Mammals	4.34E-09	mg/kg				
Dinitrophenol, 2,4-	Ingestion of Marine Mammals	1.84E-07	mg/kg	1.71E-07	3.52E-11	7.97E-07	5.47E-11
Dinitrotoluene, 2,4-	Ingestion of Marine Mammals	5.88E-08	mg/kg	1.81E-07		8.45E-07	
Dinitrotoluene, 2,6-	Ingestion of Marine Mammals	7.35E-08	mg/kg	5.79E-08		2.70E-07	
Heptachlor Epoxide	Ingestion of Marine Mammals	2.13E-08	mg/kg	1.45E-07		6.75E-07	
Hexachlorobenzene	Ingestion of Marine Mammals	1.75E-04	mg/kg	3.23E-06	9.81E-11	1.51E-05	1.53E-10
Hexachlorobutadiene	Ingestion of Marine Mammals	2.01E-06	mg/kg	4.31E-04	1.42E-07	2.01E-03	2.20E-07
Hexachlorocyclopentadiene	Ingestion of Marine Mammals	8.47E-04	mg/kg	2.38E-04	7.94E-11		1.23E-10
Hexachloroethane	Ingestion of Marine Mammals	9.67E-07	mg/kg	1.90E-06	6.85E-12	1.11E-03	1.07E-11
Indeno(1,2,3-cd)pyrene	Ingestion of Marine Mammals	3.42E-01	mg/kg		1.26E-04	8.88E-06	1.97E-04
Nitrobenzene	Ingestion of Marine Mammals	7.69E-08	mg/kg	3.03E-07		1.41E-06	
Nitrosodi-N-propylamine, N-	Ingestion of Marine Mammals	1.65E-08	mg/kg		5.85E-11		9.09E-11
Oxybis(1-chloropropane), 2,2'-	Ingestion of Marine Mammals	1.24E-07	mg/kg				
Pentachlorophenol	Ingestion of Marine Mammals	5.29E-04	mg/kg	3.47E-05	3.21E-08	1.62E-04	5.00E-08
Tetrachloroethane, 1,1,2,2-	Ingestion of Marine Mammals	2.64E-07	mg/kg		2.67E-11		4.16E-11
Tetrachloroethylene	Ingestion of Marine Mammals	1.89E-07	mg/kg	3.72E-08		1.74E-07	
Toxaphene	Ingestion of Marine Mammals	1.21E-07	mg/kg		6.74E-11		1.05E-10
Trichlorobenzene, 1,2,4-	Ingestion of Marine Mammals	1.59E-06	mg/kg	3.13E-07		1.46E-06	
Trichloroethane, 1,1,2-	Ingestion of Marine Mammals	1.40E-07	mg/kg	6.89E-08	4.04E-12	3.22E-07	6.28E-12
Trichloroethylene	Ingestion of Marine Mammals	1.86E-07	mg/kg	6.10E-08		2.85E-07	
Trichlorophenol, 2,4,6-	Ingestion of Marine Mammals	1.56E-06	mg/kg		8.69E-12		1.35E-11
Vinyl Chloride	Ingestion of Marine Mammals	9.05E-09	mg/kg		8.70E-12		1.35E-11
Antimony (metallic)	Dermal Contact with Soil	5.00E+00	mg/kg				
Aroclor 1016	Dermal Contact with Soil	1.50E-01	mg/kg				
Aroclor 1221	Dermal Contact with Soil	1.80E-01	mg/kg				
Aroclor 1232	Dermal Contact with Soil	7.50E-02	mg/kg				
Aroclor 1248	Dermal Contact with Soil	6.00E-02	mg/kg				
Aroclor-1242	Dermal Contact with Soil	9.00E-02	mg/kg				
Benzo(k)fluoranthene	Dermal Contact with Soil	1.35E+00	mg/kg				
Bis(2-ethylhexyl)Phthalate (DE	Dermal Contact with Soil	7.50E-01	mg/kg	1.60E-04	3.49E-09	2.96E-04	2.15E-09
Bis(Chloroethyl)ether	Dermal Contact with Soil	7.00E-01	mg/kg				
Bromodichloromethane	Dermal Contact with Soil	1.45E-01	mg/kg				
Carbon Tetrachloride	Dermal Contact with Soil	2.15E-01	mg/kg				
Dibenz(a,h)anthracene	Dermal Contact with Soil	4.00E-01	mg/kg				

Table F-6. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Beach area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Dichlorobenzene, 1,4-	Dermal Contact with Soil	4.50E-01	mg/kg				
Dichlorobenzidine, 3,3'	Dermal Contact with Soil	1.05E+00	mg/kg				
Dichloroethene, 1,1-	Dermal Contact with Soil	2.55E-01	mg/kg				
Dichloropropene, Cis-1,3-	Dermal Contact with Soil	1.55E-01	mg/kg				
Dichloropropene, Trans-1,3-	Dermal Contact with Soil	1.20E-01	mg/kg				
Hexachlorobenzene	Dermal Contact with Soil	6.00E-01	mg/kg				
Hexachlorobutadiene	Dermal Contact with Soil	6.00E-01	mg/kg				
Hexachloroethane	Dermal Contact with Soil	7.00E-01	mg/kg				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Soil	5.00E-01	mg/kg				
Isophorone	Dermal Contact with Soil	1.15E+00	mg/kg	7.26E-06	3.07E-10	1.34E-05	1.89E-10
Nitroaniline, 3-	Dermal Contact with Soil	2.05E+00	mg/kg				
Nitroaniline, 4-	Dermal Contact with Soil	2.45E+00	mg/kg				
Nitrobenzene	Dermal Contact with Soil	1.30E+00	mg/kg				
Nitrosodi-N-propylamine, N-	Dermal Contact with Soil	3.45E+00	mg/kg				
Nitrosodiphenylamine, N-	Dermal Contact with Soil	1.55E+00	mg/kg				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Soil	6.00E-01	mg/kg				
Pentachlorophenol	Dermal Contact with Soil	6.00E-01	mg/kg				
Tetrachloroethane, 1,1,2,2-	Dermal Contact with Soil	2.00E-01	mg/kg				
Toxaphene	Dermal Contact with Soil	1.25E-01	mg/kg				
Trichlorophenol, 2,4,6-	Dermal Contact with Soil	8.00E-01	mg/kg				
Vinyl Chloride	Dermal Contact with Soil	2.10E-01	mg/kg				
Antimony (metallic)	Ingestion of Soil	5.00E+00	mg/kg	5.87E-03		5.48E-02	
Aroclor 1016	Ingestion of Soil	1.50E-01	mg/kg	1.01E-03		9.39E-03	
Aroclor 1221	Ingestion of Soil	1.80E-01	mg/kg	1.21E-03	1.67E-07	1.13E-02	5.21E-07
Aroclor 1232	Ingestion of Soil	7.50E-02	mg/kg	5.03E-04	6.97E-08	4.70E-03	2.17E-07
Aroclor 1248	Ingestion of Soil	6.00E-02	mg/kg	4.03E-04	5.58E-08	3.76E-03	1.74E-07
Aroclor-1242	Ingestion of Soil	9.00E-02	mg/kg				
Benzo(k)fluoranthene	Ingestion of Soil	1.35E+00	mg/kg		1.19E-08		3.70E-08
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Soil	7.50E-01	mg/kg	1.76E-05	1.27E-09	1.64E-04	3.95E-09
Bis(Chloroethyl)ether	Ingestion of Soil	7.00E-01	mg/kg		9.30E-08		2.89E-07
Bromodichloromethane	Ingestion of Soil	1.45E-01	mg/kg	3.41E-06	1.09E-09	3.18E-05	3.38E-09
Carbon Tetrachloride	Ingestion of Soil	2.15E-01	mg/kg	1.44E-04	3.38E-09	1.35E-03	1.05E-08
Dibenz(a,h)anthracene	Ingestion of Soil	4.00E-01	mg/kg		3.53E-07		1.10E-06
Dichlorobenzene, 1,4-	Ingestion of Soil	4.50E-01	mg/kg		1.30E-09		4.06E-09
Dichlorobenzidine, 3,3'	Ingestion of Soil	1.05E+00	mg/kg		5.71E-08		1.78E-07
Dichloroethene, 1,1-	Ingestion of Soil	2.55E-01	mg/kg		1.85E-08	1.24E-04	5.75E-08
Dichloropropene, Cis-1,3-	Ingestion of Soil	1.55E-01	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Soil	1.20E-01	mg/kg				

Table F-6. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Beach area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Hexachlorobenzene	Ingestion of Soil	6.00E-01	mg/kg	3.52E-04	1.16E-07	3.29E-03	3.61E-07
Hexachlorobutadiene	Ingestion of Soil	6.00E-01	mg/kg		5.65E-09		1.76E-08
Hexachloroethane	Ingestion of Soil	7.00E-01	mg/kg	3.29E-04	1.18E-09	3.07E-03	3.68E-09
Indeno(1,2,3-cd)pyrene	Ingestion of Soil	5.00E-01	mg/kg		4.41E-08		1.37E-07
Isophorone	Ingestion of Soil	1.15E+00	mg/kg	2.70E-06	1.32E-10	2.52E-05	4.10E-10
Nitroaniline, 3-	Ingestion of Soil	2.05E+00	mg/kg	3.21E-04		3.00E-03	
Nitroaniline, 4-	Ingestion of Soil	2.45E+00	mg/kg	3.84E-04		3.58E-03	
Nitrobenzene	Ingestion of Soil	1.30E+00	mg/kg	1.22E-03		1.14E-02	
Nitrosodi-N-propylamine, N-	Ingestion of Soil	3.45E+00	mg/kg		2.92E-06		9.07E-06
Nitrosodiphenylamine, N-	Ingestion of Soil	1.55E+00	mg/kg		9.17E-10		2.85E-09
Oxybis(1-chloropropane), 2,2'-	Ingestion of Soil	6.00E-01	mg/kg				
Pentachlorophenol	Ingestion of Soil	6.00E-01	mg/kg	9.39E-06	8.70E-09	8.77E-05	2.71E-08
Tetrachloroethane, 1,1,2,2-	Ingestion of Soil	2.00E-01	mg/kg		4.83E-09		1.50E-08
Toxaphene	Ingestion of Soil	1.25E-01	mg/kg		1.66E-08		5.17E-08
Trichlorophenol, 2,4,6-	Ingestion of Soil	8.00E-01	mg/kg		1.06E-09		3.31E-09
Vinyl Chloride	Ingestion of Soil	2.10E-01	mg/kg		4.82E-08		1.50E-07
Aldrin	Dermal Contact with Surface Water	5.00E-09	mg/l	3.13E-05	1.03E-09	5.79E-05	6.33E-10
Aroclor 1016	Dermal Contact with Surface Water	2.25E-07	mg/l				
Aroclor 1221	Dermal Contact with Surface Water	2.00E-07	mg/l				
Aroclor 1232	Dermal Contact with Surface Water	2.00E-07	mg/l				
Aroclor 1248	Dermal Contact with Surface Water	2.00E-07	mg/l				
Aroclor 1254	Dermal Contact with Surface Water	2.50E-07	mg/l				
Aroclor 1260	Dermal Contact with Surface Water	2.50E-07	mg/l				
Aroclor-1242	Dermal Contact with Surface Water	1.75E-07	mg/l	3.73E-04	5.17E-08	6.90E-04	3.19E-08
Arsenic (inorganic)	Dermal Contact with Surface Water	2.50E-08	mg/l				
Benzo(a)anthracene	Dermal Contact with Surface Water	2.25E-06	mg/l		4.67E-08		2.88E-08
Benzo(a)pyrene	Dermal Contact with Surface Water	5.00E-07	mg/l		1.10E-07		6.80E-08
Benzo(b)fluoranthene	Dermal Contact with Surface Water	5.00E-07	mg/l		1.04E-08		6.40E-09
Benzo(k)fluoranthene	Dermal Contact with Surface Water	7.50E-07	mg/l				
Bis(Chloroethyl)ether	Dermal Contact with Surface Water	1.50E-06	mg/l				
Bromodichloromethane	Dermal Contact with Surface Water	2.00E-06	mg/l				
Bromoform	Dermal Contact with Surface Water	2.00E-06	mg/l				
Bromomethane	Dermal Contact with Surface Water	2.00E-06	mg/l				
Carbon Disulfide	Dermal Contact with Surface Water	2.00E-06	mg/l				
Carbon Tetrachloride	Dermal Contact with Surface Water	2.00E-06	mg/l				
Chloroaniline, 4-	Dermal Contact with Surface Water	1.50E-06	mg/l				
Chlorobenzene	Dermal Contact with Surface Water	1.50E-06	mg/l				
Chloromethane	Dermal Contact with Surface Water	8.25E-06	mg/l				

Table F-6. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Beach area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Chrysene	Dermal Contact with Surface Water	5.00E-07	mg/l		1.01E-10		6.25E-11
Dibenz(a,h)anthracene	Dermal Contact with Surface Water	2.25E-06	mg/l				
Dibenzofuran	Dermal Contact with Surface Water	5.00E-07	mg/l				
Dibromochloromethane	Dermal Contact with Surface Water	2.00E-06	mg/l				
Dichlorobenzene, 1,4-	Dermal Contact with Surface Water	1.25E-06	mg/l				
Dichlorobenzidine, 3,3'	Dermal Contact with Surface Water	1.75E-06	mg/l				
Dichloroethane, 1,2-	Dermal Contact with Surface Water	5.50E-06	mg/l				
Dichloroethene, 1,1-	Dermal Contact with Surface Water	5.75E-06	mg/l				
Dichloromethane	Dermal Contact with Surface Water	1.75E-06	mg/l				
Dichlorophenol, 2,4-	Dermal Contact with Surface Water	7.50E-07	mg/l				
Dichloropropane, 1,2-	Dermal Contact with Surface Water	2.00E-06	mg/l				
Dichloropropene, Cis-1,3-	Dermal Contact with Surface Water	1.50E-06	mg/l				
Dichloropropene, Trans-1,3-	Dermal Contact with Surface Water	2.00E-06	mg/l				
Dieldrin	Dermal Contact with Surface Water	5.00E-09	mg/l	1.88E-05	3.86E-09	3.48E-05	2.38E-09
Dinitrophenol, 2,4-	Dermal Contact with Surface Water	7.50E-06	mg/l				
Dinitrotoluene, 2,4-	Dermal Contact with Surface Water	1.00E-06	mg/l	5.22E-05		9.66E-05	
Dinitrotoluene, 2,6-	Dermal Contact with Surface Water	1.25E-06	mg/l				
Heptachlor Epoxide	Dermal Contact with Surface Water	2.50E-09	mg/l	2.74E-05	8.33E-10	5.06E-05	5.14E-10
Hexachlorobenzene	Dermal Contact with Surface Water	5.00E-07	mg/l				
Hexachlorobutadiene	Dermal Contact with Surface Water	5.00E-07	mg/l				
Hexachlorocyclopentadiene	Dermal Contact with Surface Water	2.25E-06	mg/l				
Hexachloroethane	Dermal Contact with Surface Water	5.00E-07	mg/l				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Surface Water	2.00E-06	mg/l				
Nitroaniline, 2-	Dermal Contact with Surface Water	1.75E-06	mg/l				
Nitroaniline, 3-	Dermal Contact with Surface Water	2.18E-05	mg/l				
Nitroaniline, 4-	Dermal Contact with Surface Water	1.78E-05	mg/l				
Nitrobenzene	Dermal Contact with Surface Water	1.75E-06	mg/l				
Nitrosodi-N-propylamine, N-	Dermal Contact with Surface Water	1.00E-06	mg/l				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Surface Water	7.50E-07	mg/l				
Pentachlorophenol	Dermal Contact with Surface Water	1.48E-05	mg/l				
Styrene	Dermal Contact with Surface Water	1.25E-06	mg/l				
Tetrachloroethane, 1,1,2,2-	Dermal Contact with Surface Water	2.25E-06	mg/l				
Tetrachloroethylene	Dermal Contact with Surface Water	1.25E-06	mg/l				
Toxaphene	Dermal Contact with Surface Water	1.98E-07	mg/l				
Trichlorobenzene, 1,2,4-	Dermal Contact with Surface Water	7.50E-07	mg/l				
Trichloroethane, 1,1,2-	Dermal Contact with Surface Water	1.75E-06	mg/l				
Trichloroethylene	Dermal Contact with Surface Water	1.50E-06	mg/l				
Trichlorophenol, 2,4,6-	Dermal Contact with Surface Water	1.25E-06	mg/l				

Table F-6. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Beach area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Vinyl Chloride	Dermal Contact with Surface Water	2.00E-06	mg/l				
Aldrin	Ingestion of Surface Water	5.00E-09	mg/l	6.26E-08	8.21E-12	2.92E-07	1.28E-11
Aroclor 1016	Ingestion of Surface Water	2.25E-07	mg/l	1.21E-06		5.64E-06	
Aroclor 1221	Ingestion of Surface Water	2.00E-07	mg/l	1.07E-06	1.49E-10	5.01E-06	2.31E-10
Aroclor 1232	Ingestion of Surface Water	2.00E-07	mg/l	1.07E-06	1.49E-10	5.01E-06	2.31E-10
Aroclor 1248	Ingestion of Surface Water	2.00E-07	mg/l	1.07E-06	1.49E-10	5.01E-06	2.31E-10
Aroclor 1254	Ingestion of Surface Water	2.50E-07	mg/l	4.70E-06		2.19E-05	
Aroclor 1260	Ingestion of Surface Water	2.50E-07	mg/l	1.34E-06	1.86E-10	6.26E-06	2.89E-10
Aroclor-1242	Ingestion of Surface Water	1.75E-07	mg/l				
Arsenic (inorganic)	Ingestion of Surface Water	2.50E-08	mg/l	3.13E-08	4.23E-12	1.46E-07	6.58E-12
Benzo(a)anthracene	Ingestion of Surface Water	2.25E-06	mg/l		1.59E-10		2.47E-10
Benzo(a)pyrene	Ingestion of Surface Water	5.00E-07	mg/l		3.53E-10		5.49E-10
Benzo(b)fluoranthene	Ingestion of Surface Water	5.00E-07	mg/l		3.53E-11		5.49E-11
Benzo(k)fluoranthene	Ingestion of Surface Water	7.50E-07	mg/l		5.29E-12		8.23E-12
Bis(Chloroethyl)ether	Ingestion of Surface Water	1.50E-06	mg/l		1.59E-10		2.48E-10
Bromodichloromethane	Ingestion of Surface Water	2.00E-06	mg/l	3.76E-08	1.20E-11	1.75E-07	1.86E-11
Bromoform	Ingestion of Surface Water	2.00E-06	mg/l	3.76E-08	1.53E-12	1.75E-07	2.37E-12
Bromomethane	Ingestion of Surface Water	2.00E-06	mg/l	5.37E-07		2.50E-06	
Carbon Disulfide	Ingestion of Surface Water	2.00E-06	mg/l	7.51E-09		3.51E-08	
Carbon Tetrachloride	Ingestion of Surface Water	2.00E-06	mg/l	1.07E-06	2.51E-11	5.01E-06	3.91E-11
Chloroaniline, 4-	Ingestion of Surface Water	1.50E-06	mg/l	1.41E-07		6.58E-07	
Chlorobenzene	Ingestion of Surface Water	1.50E-06	mg/l	2.82E-08		1.32E-07	
Chloromethane	Ingestion of Surface Water	8.25E-06	mg/l				
Chrysene	Ingestion of Surface Water	5.00E-07	mg/l		3.53E-13		5.49E-13
Dibenz(a,h)anthracene	Ingestion of Surface Water	2.25E-06	mg/l		1.59E-09		2.47E-09
Dibenzofuran	Ingestion of Surface Water	5.00E-07	mg/l	4.70E-08		2.19E-07	
Dibromochloromethane	Ingestion of Surface Water	2.00E-06	mg/l	3.76E-08	1.62E-11	1.75E-07	2.52E-11
Dichlorobenzene, 1,4-	Ingestion of Surface Water	1.25E-06	mg/l		2.90E-12		4.51E-12
Dichlorobenzidine, 3,3'	Ingestion of Surface Water	1.75E-06	mg/l		7.61E-11		1.18E-10
Dichloroethane, 1,2-	Ingestion of Surface Water	5.50E-06	mg/l		4.84E-11		7.52E-11
Dichloroethene, 1,1-	Ingestion of Surface Water	5.75E-06	mg/l	2.40E-07	3.33E-10	1.12E-06	5.19E-10
Dichloromethane	Ingestion of Surface Water	1.75E-06	mg/l	1.10E-08	1.27E-12	5.11E-08	1.97E-12
Dichlorophenol, 2,4-	Ingestion of Surface Water	7.50E-07	mg/l	9.39E-08		4.38E-07	
Dichloropropane, 1,2-	Ingestion of Surface Water	2.00E-06	mg/l		1.31E-11		2.04E-11
Dichloropropene, Cis-1,3-	Ingestion of Surface Water	1.50E-06	mg/l				
Dichloropropene, Trans-1,3-	Ingestion of Surface Water	2.00E-06	mg/l				
Dieldrin	Ingestion of Surface Water	5.00E-09	mg/l	3.76E-08	7.73E-12	1.75E-07	1.20E-11
Dinitrophenol, 2,4-	Ingestion of Surface Water	7.50E-06	mg/l	1.41E-06		6.58E-06	

Table F-6. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Beach area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Dinitrotoluene, 2,4-	Ingestion of Surface Water	1.00E-06	mg/l	1.88E-07		8.77E-07	
Dinitrotoluene, 2,6-	Ingestion of Surface Water	1.25E-06	mg/l	4.70E-07		2.19E-06	
Heptachlor Epoxide	Ingestion of Surface Water	2.50E-09	mg/l	7.23E-08	2.20E-12	3.37E-07	3.42E-12
Hexachlorobenzene	Ingestion of Surface Water	5.00E-07	mg/l	2.35E-07	7.73E-11	1.10E-06	1.20E-10
Hexachlorobutadiene	Ingestion of Surface Water	5.00E-07	mg/l		3.77E-12		5.86E-12
Hexachlorocyclopentadiene	Ingestion of Surface Water	2.25E-06	mg/l	1.21E-07		5.64E-07	
Hexachloroethane	Ingestion of Surface Water	5.00E-07	mg/l	1.88E-07	6.76E-13	8.77E-07	1.05E-12
Indeno(1,2,3-cd)pyrene	Ingestion of Surface Water	2.00E-06	mg/l		1.41E-10		2.19E-10
Nitroaniline, 2-	Ingestion of Surface Water	1.75E-06	mg/l	1.10E-05		5.11E-05	
Nitroaniline, 3-	Ingestion of Surface Water	2.18E-05	mg/l	2.73E-06		1.27E-05	
Nitroaniline, 4-	Ingestion of Surface Water	1.78E-05	mg/l	2.23E-06		1.04E-05	
Nitrobenzene	Ingestion of Surface Water	1.75E-06	mg/l	1.32E-06		6.14E-06	
Nitrosodi-N-propylamine, N-	Ingestion of Surface Water	1.00E-06	mg/l		6.76E-10		1.05E-09
Oxybis(1-chloropropane), 2,2'-	Ingestion of Surface Water	7.50E-07	mg/l				
Pentachlorophenol	Ingestion of Surface Water	1.48E-05	mg/l	1.85E-07	1.72E-10	8.65E-07	2.67E-10
Styrene	Ingestion of Surface Water	1.25E-06	mg/l	2.35E-09		1.10E-08	
Tetrachloroethane, 1,1,2,2-	Ingestion of Surface Water	2.25E-06	mg/l		4.35E-11		6.76E-11
Tetrachloroethylene	Ingestion of Surface Water	1.25E-06	mg/l	4.70E-08		2.19E-07	
Toxaphene	Ingestion of Surface Water	1.98E-07	mg/l		2.10E-11		3.27E-11
Trichlorobenzene, 1,2,4-	Ingestion of Surface Water	7.50E-07	mg/l	2.82E-08		1.32E-07	
Trichloroethane, 1,1,2-	Ingestion of Surface Water	1.75E-06	mg/l	1.64E-07	9.64E-12	7.67E-07	1.50E-11
Trichloroethylene	Ingestion of Surface Water	1.50E-06	mg/l	9.39E-08		4.38E-07	
Trichlorophenol, 2,4,6-	Ingestion of Surface Water	1.25E-06	mg/l		1.33E-12		2.07E-12
Vinyl Chloride	Ingestion of Surface Water	2.00E-06	mg/l		3.67E-10		5.71E-10
TOTAL RISK				8.32E-01	3.61E-04	3.94E+00	5.68E-04

Table F-7. Carcinogenic and Non-carcinogenic Risk Values for Non-detected Chemicals at the East Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Antimony (metallic)	Ingestion of Berries	8.15E+00	mg/kg	5.38E+00		2.51E+01	
Aroclor 1016	Ingestion of Berries	8.29E-05	mg/kg	3.12E-04		1.46E-03	
Aroclor 1221	Ingestion of Berries	1.58E-02	mg/kg	5.96E-02	8.25E-06	2.78E-01	1.28E-05
Aroclor 1232	Ingestion of Berries	2.41E-03	mg/kg	9.08E-03	1.26E-06	4.24E-02	1.96E-06
Aroclor 1248	Ingestion of Berries	2.85E-01	mg/kg	1.07E+00	1.49E-04	5.01E+00	2.32E-04
Aroclor-1242	Ingestion of Berries	3.32E-05	mg/kg				
Benzo(k)fluoranthene	Ingestion of Berries	3.13E-06	mg/kg		1.55E-11		2.41E-11
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Berries	4.82E-04	mg/kg	6.36E-06	4.58E-10	2.97E-05	7.12E-10
Bis(Chloroethyl)ether	Ingestion of Berries	6.47E-01	mg/kg		4.83E-05		7.51E-05
Bromodichloromethane	Ingestion of Berries	1.71E-01	mg/kg	2.26E-03	7.19E-07	1.05E-02	1.12E-06
Dibenz(a,h)anthracene	Ingestion of Berries	4.11E-06	mg/kg		2.04E-09		3.17E-09
Dichlorobenzene, 1,4-	Ingestion of Berries	1.77E-02	mg/kg		2.88E-08		4.48E-08
Dichlorobenzidine, 3,3'	Ingestion of Berries	5.75E-02	mg/kg		1.76E-06		2.73E-06
Dichloroethene, 1,1-	Ingestion of Berries	2.15E-01	mg/kg	6.30E-03	8.75E-06	2.94E-02	1.36E-05
Dichloropropene, Cis-1,3-	Ingestion of Berries	1.83E-01	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Berries	1.39E-01	mg/kg				
Hexachlorobenzene	Ingestion of Berries	2.32E-04	mg/kg	7.65E-05	2.52E-08	3.57E-04	3.92E-08
Hexachlorobutadiene	Ingestion of Berries	5.48E-03	mg/kg		2.90E-08		4.51E-08
Hexachloroethane	Ingestion of Berries	1.29E-02	mg/kg	3.40E-03	1.23E-08	1.59E-02	1.91E-08
Indeno(1,2,3-cd)pyrene	Ingestion of Berries	2.85E-08	mg/kg		1.41E-12		2.20E-12
Isophorone	Ingestion of Berries	4.06E+00	mg/kg	5.36E-03	2.62E-07	2.50E-02	4.07E-07
Nitroaniline, 3-	Ingestion of Berries	1.79E+00	mg/kg	1.57E-01		7.35E-01	
Nitroaniline, 4-	Ingestion of Berries	2.12E+00	mg/kg	1.86E-01		8.70E-01	
Nitrobenzene	Ingestion of Berries	3.65E-01	mg/kg	1.93E-01		8.99E-01	
Nitrosodi-N-propylamine, N-	Ingestion of Berries	1.27E+00	mg/kg		6.03E-04		9.38E-04
Nitrosodiphenylamine, N-	Ingestion of Berries	1.05E-01	mg/kg		3.49E-08		5.43E-08
Oxybis(1-chloropropane), 2,2'-	Ingestion of Berries	5.30E-01	mg/kg				
Pentachlorophenol	Ingestion of Berries	9.03E-04	mg/kg	7.94E-06		3.71E-05	1.14E-08
Tetrachloroethane, 1,1,2,2-	Ingestion of Berries	4.97E-02	mg/kg		6.74E-07		1.05E-06
Toxaphene	Ingestion of Berries	3.75E-02	mg/kg		2.80E-06		4.35E-06
Trichlorophenol, 2,4,6-	Ingestion of Berries	2.27E-02	mg/kg		1.69E-08		2.64E-08
Vinyl Chloride	Ingestion of Berries	3.43E-01	mg/kg		4.42E-05		6.88E-05
Aldrin	Dermal Contact with Sediment	2.40E-03	mg/kg	1.88E-04	6.16E-09	3.47E-04	3.79E-09
Antimony (metallic)	Dermal Contact with Sediment	1.00E+01	mg/kg				
Aroclor 1016	Dermal Contact with Sediment	3.45E-01	mg/kg				
Aroclor 1221	Dermal Contact with Sediment	4.10E-01	mg/kg				
Aroclor 1232	Dermal Contact with Sediment	1.80E-01	mg/kg				

Table F-7. Carcinogenic and Non-carcinogenic Risk Values for Non-detected Chemicals at the East Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Aroclor 1248	Dermal Contact with Sediment	1.40E-01	mg/kg				
Aroclor-1242	Dermal Contact with Sediment	2.10E-01	mg/kg				
Benzo(a)anthracene	Dermal Contact with Sediment	2.00E-01	mg/kg		1.56E-07		9.59E-08
Benzo(a)pyrene	Dermal Contact with Sediment	2.00E-01	mg/kg		1.65E-06		1.02E-06
Benzo(b)fluoranthene	Dermal Contact with Sediment	2.00E-01	mg/kg		1.56E-07		9.59E-08
Benzo(k)fluoranthene	Dermal Contact with Sediment	3.50E-01	mg/kg				
Bis(Chloroethyl)ether	Dermal Contact with Sediment	2.00E-01	mg/kg				
Cadmium (food)	Dermal Contact with Sediment	1.50E+00	mg/kg				
Chrysene	Dermal Contact with Sediment	2.00E-01	mg/kg		1.52E-09		9.36E-10
Dibenz(a,h)anthracene	Dermal Contact with Sediment	1.00E-01	mg/kg				
Dichlorobenzidine, 3,3'	Dermal Contact with Sediment	3.00E-01	mg/kg				
Dichloroethene, 1,1-	Dermal Contact with Sediment	3.00E-03	mg/kg				
Dieldrin	Dermal Contact with Sediment	4.75E-03	mg/kg				
Dinitrotoluene, 2,4-	Dermal Contact with Sediment	1.00E-01	mg/kg	2.23E-04	4.59E-08	4.12E-04	2.83E-08
Dinitrotoluene, 2,6-	Dermal Contact with Sediment	2.00E-01	mg/kg	1.30E-04		2.41E-04	
Heptachlor	Dermal Contact with Sediment	3.45E-03	mg/kg				
Hexachlorobenzene	Dermal Contact with Sediment	1.50E-01	mg/kg				
Hexachlorobutadiene	Dermal Contact with Sediment	1.50E-01	mg/kg				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Sediment	1.50E-01	mg/kg				
Nitroaniline, 3-	Dermal Contact with Sediment	5.50E-01	mg/kg				
Nitroaniline, 4-	Dermal Contact with Sediment	6.50E-01	mg/kg				
Nitrosodi-N-propylamine, N-	Dermal Contact with Sediment	1.50E-01	mg/kg				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Sediment	1.50E-01	mg/kg				
Pentachlorophenol	Dermal Contact with Sediment	1.60E-01	mg/kg				
Selenium (and compounds)	Dermal Contact with Sediment	1.00E+01	mg/kg				
Tetrachloroethane, 1,1,2,2-	Dermal Contact with Sediment	2.40E-04	mg/kg				
Toxaphene	Dermal Contact with Sediment	2.90E-01	mg/kg				
Vinyl Chloride	Dermal Contact with Sediment	2.50E-03	mg/kg				
Aldrin	Ingestion of Sediment	2.40E-03	mg/kg	3.76E-05	4.93E-09	3.51E-04	1.53E-08
Antimony (metallic)	Ingestion of Sediment	1.00E+01	mg/kg	1.17E-02		1.10E-01	
Aroclor 1016	Ingestion of Sediment	3.45E-01	mg/kg	2.31E-03		2.16E-02	
Aroclor 1221	Ingestion of Sediment	4.10E-01	mg/kg	2.75E-03	3.81E-07	2.57E-02	1.19E-06
Aroclor 1232	Ingestion of Sediment	1.80E-01	mg/kg	1.21E-03	1.67E-07	1.13E-02	5.21E-07
Aroclor 1248	Ingestion of Sediment	1.40E-01	mg/kg	9.39E-04	1.30E-07	8.77E-03	4.05E-07
Aroclor-1242	Ingestion of Sediment	2.10E-01	mg/kg				
Benzo(a)anthracene	Ingestion of Sediment	2.00E-01	mg/kg		1.76E-08		5.49E-08

Table F-7. Carcinogenic and Non-carcinogenic Risk Values for Non-detected Chemicals at the East Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Benzo(a)pyrene	Ingestion of Sediment	2.00E-01	mg/kg		1.76E-07		5.49E-07
Benzo(b)fluoranthene	Ingestion of Sediment	2.00E-01	mg/kg		1.76E-08		5.49E-08
Benzo(k)fluoranthene	Ingestion of Sediment	3.50E-01	mg/kg		3.09E-09		9.60E-09
Bis(Chloroethyl)ether	Ingestion of Sediment	2.00E-01	mg/kg		2.66E-08		8.27E-08
Cadmium (food)	Ingestion of Sediment	1.50E+00	mg/kg	7.05E-04		6.58E-03	
Chrysene	Ingestion of Sediment	2.00E-01	mg/kg		1.76E-10		5.49E-10
Dibenz(a,h)anthracene	Ingestion of Sediment	1.00E-01	mg/kg		8.82E-08		2.74E-07
Dichlorobenzidine, 3,3'	Ingestion of Sediment	3.00E-01	mg/kg		1.63E-08		5.07E-08
Dichloroethene, 1,1-	Ingestion of Sediment	3.00E-03	mg/kg		2.17E-10	1.46E-06	6.76E-10
Dieldrin	Ingestion of Sediment	4.75E-03	mg/kg	1.57E-07	9.18E-09	4.16E-04	2.86E-08
Dinitrotoluene, 2,4-	Ingestion of Sediment	1.00E-01	mg/kg	4.46E-05		2.19E-04	
Dinitrotoluene, 2,6-	Ingestion of Sediment	2.00E-01	mg/kg	2.35E-05		8.77E-04	
Heptachlor	Ingestion of Sediment	3.45E-03	mg/kg	9.39E-05		3.02E-05	5.83E-09
Hexachlorobenzene	Ingestion of Sediment	1.50E-01	mg/kg	3.24E-06	1.87E-09		9.02E-08
Hexachlorobutadiene	Ingestion of Sediment	1.50E-01	mg/kg	8.81E-05	2.90E-08	8.22E-04	4.40E-09
Indeno(1,2,3-cd)pyrene	Ingestion of Sediment	1.50E-01	mg/kg		1.41E-09		4.11E-08
Nitroaniline, 3-	Ingestion of Sediment	1.50E-01	mg/kg		1.32E-08	8.04E-04	
Nitroaniline, 4-	Ingestion of Sediment	5.50E-01	mg/kg	8.61E-05		9.50E-04	
Nitrosodi-N-propylamine, N'-	Ingestion of Sediment	6.50E-01	mg/kg	1.02E-04	1.27E-07		3.95E-07
Oxybis(1-chloropropane), 2,2'-	Ingestion of Sediment	1.50E-01	mg/kg				
Pentachlorophenol	Ingestion of Sediment	1.60E-01	mg/kg		2.32E-09	2.34E-05	7.21E-09
Selenium (and compounds)	Ingestion of Sediment	1.00E+01	mg/kg	2.50E-06		8.77E-03	
Tetrachloroethane, 1,1,2,2-	Ingestion of Sediment	2.40E-04	mg/kg		5.80E-12		1.80E-11
Toxaphene	Ingestion of Sediment	2.90E-01	mg/kg		3.85E-08		1.20E-07
Vinyl Chloride	Ingestion of Sediment	2.50E-03	mg/kg		5.74E-10		1.78E-09
Antimony (metallic)	Dermal Contact with Soil	1.00E+01	mg/kg				
Aroclor 1016	Dermal Contact with Soil	9.00E-01	mg/kg				
Aroclor 1221	Dermal Contact with Soil	1.05E+00	mg/kg				
Aroclor 1232	Dermal Contact with Soil	4.50E-01	mg/kg				
Aroclor 1248	Dermal Contact with Soil	3.50E-01	mg/kg				
Aroclor-1242	Dermal Contact with Soil	5.50E-01	mg/kg				
Benzo(k)fluoranthene	Dermal Contact with Soil	1.45E+00	mg/kg				
Bis(2-ethylhexyl)Phthalate (DE	Dermal Contact with Soil	8.00E-01	mg/kg	1.71E-04	3.72E-09	3.16E-04	2.29E-09
Bis(Chloroethyl)ether	Dermal Contact with Soil	7.50E-01	mg/kg				
Bromodichloromethane	Dermal Contact with Soil	2.10E-01	mg/kg				
Dibenz(a,h)anthracene	Dermal Contact with Soil	4.50E-01	mg/kg				
Dichlorobenzene, 1,4-	Dermal Contact with Soil	5.00E-01	mg/kg				

Table F-7. Carcinogenic and Non-carcinogenic Risk Values for Non-detected Chemicals at the East Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Dichlorobenzidine, 3,3'	Dermal Contact with Soil	1.15E+00	mg/kg				
Dichloroethene, 1,1-	Dermal Contact with Soil	3.75E-01	mg/kg				
Dichloropropene, Cis-1,3-	Dermal Contact with Soil	2.25E-01	mg/kg				
Dichloropropene, Trans-1,3-	Dermal Contact with Soil	1.70E-01	mg/kg				
Hexachlorobenzene	Dermal Contact with Soil	6.50E-01	mg/kg				
Hexachlorobutadiene	Dermal Contact with Soil	6.50E-01	mg/kg				
Hexachloroethane	Dermal Contact with Soil	7.50E-01	mg/kg				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Soil	5.50E-01	mg/kg				
Isophorone	Dermal Contact with Soil	9.50E+00	mg/kg	6.00E-05	2.54E-09	1.11E-04	1.56E-09
Nitroaniline, 3-	Dermal Contact with Soil	2.20E+00	mg/kg				
Nitroaniline, 4-	Dermal Contact with Soil	2.60E+00	mg/kg				
Nitrobenzene	Dermal Contact with Soil	1.05E+00	mg/kg				
Nitrosodi-N-propylamine, N-	Dermal Contact with Soil	1.80E+00	mg/kg				
Nitrosodiphenylamine, N-	Dermal Contact with Soil	1.65E+00	mg/kg				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Soil	6.50E-01	mg/kg				
Pentachlorophenol	Dermal Contact with Soil	6.50E-01	mg/kg				
Tetrachloroethane, 1,1,2,2-	Dermal Contact with Soil	2.95E-01	mg/kg				
Toxaphene	Dermal Contact with Soil	7.50E-01	mg/kg				
Trichlorophenol, 2,4,6-	Dermal Contact with Soil	8.50E-01	mg/kg				
Vinyl Chloride	Dermal Contact with Soil	3.05E-01	mg/kg				
Antimony (metallic)	Ingestion of Soil	1.00E+01	mg/kg	1.17E-02		1.10E-01	
Aroclor 1016	Ingestion of Soil	9.00E-01	mg/kg	6.04E-03		5.64E-02	
Aroclor 1221	Ingestion of Soil	1.05E+00	mg/kg	7.05E-03	9.76E-07	6.58E-02	3.04E-06
Aroclor 1232	Ingestion of Soil	4.50E-01	mg/kg	3.02E-03	4.18E-07	2.82E-02	1.30E-06
Aroclor 1248	Ingestion of Soil	3.50E-01	mg/kg	2.35E-03	3.25E-07	2.19E-02	1.01E-06
Aroclor-1242	Ingestion of Soil	5.50E-01	mg/kg				
Benzo(k)fluoranthene	Ingestion of Soil	1.45E+00	mg/kg		1.28E-08		3.98E-08
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Soil	8.00E-01	mg/kg	1.88E-05	1.35E-09	1.75E-04	4.21E-09
Bis(Chloroethyl)ether	Ingestion of Soil	7.50E-01	mg/kg		9.96E-08	4.60E-05	3.10E-07
Bromodichloromethane	Ingestion of Soil	2.10E-01	mg/kg	4.93E-06	1.57E-09		4.89E-09
Dibenz(a,h)anthracene	Ingestion of Soil	4.50E-01	mg/kg		3.97E-07		1.23E-06
Dichlorobenzene, 1,4-	Ingestion of Soil	5.00E-01	mg/kg		1.45E-09		4.51E-09
Dichlorobenzidine, 3,3'	Ingestion of Soil	1.15E+00	mg/kg		6.25E-08		1.94E-07
Dichloroethene, 1,1-	Ingestion of Soil	3.75E-01	mg/kg	1.96E-05	2.72E-08	1.83E-04	8.45E-08
Dichloropropene, Cis-1,3-	Ingestion of Soil	2.25E-01	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Soil	1.70E-01	mg/kg				

Table F-7. Carcinogenic and Non-carcinogenic Risk Values for Non-detected Chemicals at the East Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Hexachlorobenzene	Ingestion of Soil	6.50E-01	mg/kg	3.82E-04	1.26E-07	3.56E-03	3.91E-07
Hexachlorobutadiene	Ingestion of Soil	6.50E-01	mg/kg		6.12E-09		1.90E-08
Hexachloroethane	Ingestion of Soil	7.50E-01	mg/kg	3.52E-04	1.27E-09	3.29E-03	3.95E-09
Indeno(1,2,3-cd)pyrene	Ingestion of Soil	5.50E-01	mg/kg		4.85E-08		1.51E-07
Isophorone	Ingestion of Soil	9.50E+00	mg/kg	2.23E-05	1.09E-09	2.08E-04	3.39E-09
Nitroaniline, 3-	Ingestion of Soil	2.20E+00	mg/kg	3.44E-04		3.21E-03	
Nitroaniline, 4-	Ingestion of Soil	2.60E+00	mg/kg	4.07E-04		3.80E-03	
Nitrobenzene	Ingestion of Soil	1.05E+00	mg/kg	9.86E-04		9.21E-03	
Nitrosodi-N-propylamine, N-	Ingestion of Soil	1.80E+00	mg/kg		1.52E-06		4.73E-06
Nitrosodiphenylamine, N-	Ingestion of Soil	1.65E+00	mg/kg		9.76E-10		3.04E-09
Oxybis(1-chloropropane), 2,2'-	Ingestion of Soil	6.50E-01	mg/kg				
Pentachlorophenol	Ingestion of Soil	6.50E-01	mg/kg	1.02E-05	9.42E-09	9.50E-05	2.93E-08
Tetrachloroethane, 1,1,2,2-	Ingestion of Soil	2.95E-01	mg/kg		7.13E-09		2.22E-08
Toxaphene	Ingestion of Soil	7.50E-01	mg/kg		9.96E-08		3.10E-07
Trichlorophenol, 2,4,6-	Ingestion of Soil	8.50E-01	mg/kg		1.13E-09		3.51E-09
Vinyl Chloride	Ingestion of Soil	3.05E-01	mg/kg		7.00E-08		2.18E-07
Aroclor 1016	Dermal Contact with Surface Water	4.50E-04	mg/l				
Aroclor 1221	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1232	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1248	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1254	Dermal Contact with Surface Water	5.00E-04	mg/l				
Aroclor 1260	Dermal Contact with Surface Water	5.00E-04	mg/l	7.46E-01	1.03E-04	3.44E-01	1.59E-05
Aroclor-1242	Dermal Contact with Surface Water	3.50E-04	mg/l				
Arsenic (inorganic)	Dermal Contact with Surface Water	5.00E-05	mg/l				
Benzene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Benzo(a)anthracene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.07E-05		3.20E-06
Benzo(a)pyrene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.20E-04		3.39E-05
Benzo(b)fluoranthene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.07E-05		3.20E-06
Benzo(k)fluoranthene	Dermal Contact with Surface Water	1.50E-03	mg/l				
Bis(Chloroethyl)ether	Dermal Contact with Surface Water	3.00E-03	mg/l				
Bromodichloromethane	Dermal Contact with Surface Water	1.00E-03	mg/l				
Bromomethane	Dermal Contact with Surface Water	1.00E-03	mg/l				
Chrysene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.03E-07		3.12E-08
Dibenz(a,h)anthracene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichlorobenzidine, 3,3'	Dermal Contact with Surface Water	3.50E-03	mg/l				
Dichloroethane, 1,2-	Dermal Contact with Surface Water	1.00E-03	mg/l				

Table F-7. Carcinogenic and Non-carcinogenic Risk Values for Non-detected Chemicals at the East Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Dichloroethene, 1,1-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichloropropane, 1,2-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichloropropene, Cis-1,3-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Dichloropropene, Trans-1,3-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dinitrophenol, 2,4-	Dermal Contact with Surface Water	1.50E-02	mg/l				
Dinitrotoluene, 2,4-	Dermal Contact with Surface Water	2.00E-03	mg/l	1.04E-01		4.82E-02	
Dinitrotoluene, 2,6-	Dermal Contact with Surface Water	2.50E-03	mg/l				
Hexachlorobenzene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Hexachlorobutadiene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Nitroaniline, 2-	Dermal Contact with Surface Water	2.00E-03	mg/l				
Nitroaniline, 3-	Dermal Contact with Surface Water	1.00E-02	mg/l				
Nitroaniline, 4-	Dermal Contact with Surface Water	7.00E-03	mg/l				
Nitrosodi-N-propylamine, N-	Dermal Contact with Surface Water	2.00E-03	mg/l				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Pentachlorophenol	Dermal Contact with Surface Water	6.00E-03	mg/l				
Tetrachloroethane, 1,1,2,2-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Toxaphene	Dermal Contact with Surface Water	3.95E-04	mg/l				
Trichloroethane, 1,1,2-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Trichlorophenol, 2,4,6-	Dermal Contact with Surface Water	2.50E-03	mg/l				
Vinyl Chloride	Dermal Contact with Surface Water	1.00E-03	mg/l				
Aroclor 1016	Ingestion of Surface Water	4.50E-04	mg/l	2.42E-03		1.13E-02	
Aroclor 1221	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1232	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1248	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1254	Ingestion of Surface Water	5.00E-04	mg/l	9.39E-03		4.38E-02	
Aroclor 1260	Ingestion of Surface Water	5.00E-04	mg/l	2.68E-03	3.72E-07	1.25E-02	5.79E-07
Aroclor-1242	Ingestion of Surface Water	3.50E-04	mg/l				
Arsenic (inorganic)	Ingestion of Surface Water	5.00E-05	mg/l	6.26E-05	8.45E-09	2.92E-04	1.32E-08
Benzene	Ingestion of Surface Water	1.00E-03	mg/l		2.80E-09		4.36E-09
Benzo(a)anthracene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Benzo(a)pyrene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-07		1.10E-06
Benzo(b)fluoranthene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Benzo(k)fluoranthene	Ingestion of Surface Water	1.50E-03	mg/l		1.06E-08		1.65E-08
Bis(Chloroethyl)ether	Ingestion of Surface Water	3.00E-03	mg/l		3.19E-07		4.96E-07
Bromodichloromethane	Ingestion of Surface Water	1.00E-03	mg/l	1.88E-05	5.99E-09	8.77E-05	9.32E-09

Table F-7. Carcinogenic and Non-carcinogenic Risk Values for Non-detected Chemicals at the East Drainage area, Kortebeue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Bromomethane	Ingestion of Surface Water	1.00E-03	mg/l	2.68E-04		1.25E-03	
Chrysene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-10		1.10E-09
Dibenz(a,h)anthracene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-07		1.10E-06
Dichlorobenzidine, 3,3'	Ingestion of Surface Water	3.50E-03	mg/l		1.52E-07		2.37E-07
Dichloroethane, 1,2-	Ingestion of Surface Water	1.00E-03	mg/l		8.79E-09		1.37E-08
Dichloroethene, 1,1-	Ingestion of Surface Water	1.00E-03	mg/l	4.17E-05	5.80E-08	1.95E-04	9.02E-08
Dichloropropane, 1,2-	Ingestion of Surface Water	1.00E-03	mg/l		6.57E-09		1.02E-08
Dichloropropene, Cis-1,3-	Ingestion of Surface Water	5.00E-04	mg/l				
Dichloropropene, Trans-1,3-	Ingestion of Surface Water	1.00E-03	mg/l				
Dinitrophenol, 2,4-	Ingestion of Surface Water	1.50E-02	mg/l	2.82E-03		1.32E-02	
Dinitrotoluene, 2,4-	Ingestion of Surface Water	2.00E-03	mg/l	3.76E-04		1.75E-03	
Dinitrotoluene, 2,6-	Ingestion of Surface Water	2.50E-03	mg/l	9.39E-04		4.38E-03	
Hexachlorobenzene	Ingestion of Surface Water	1.00E-03	mg/l	4.70E-04	1.55E-07	2.19E-03	2.40E-07
Hexachlorobutadiene	Ingestion of Surface Water	1.00E-03	mg/l		7.54E-09		1.17E-08
Indeno(1,2,3-cd)pyrene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Nitroaniline, 2-	Ingestion of Surface Water	2.00E-03	mg/l	1.25E-02		5.84E-02	
Nitroaniline, 3-	Ingestion of Surface Water	1.00E-02	mg/l	1.25E-03		5.84E-03	
Nitroaniline, 4-	Ingestion of Surface Water	7.00E-03	mg/l	8.77E-04		4.09E-03	
Nitrosodi-N-propylamine, N-Oxybis(1-chloropropane), 2,2'-	Ingestion of Surface Water	2.00E-03	mg/l		1.35E-06		2.10E-06
Pentachlorophenol	Ingestion of Surface Water	5.00E-04	mg/l				
Tetrachloroethane, 1,1,2,2-	Ingestion of Surface Water	6.00E-03	mg/l	7.51E-05	6.96E-08	3.51E-04	1.08E-07
Toxaphene	Ingestion of Surface Water	1.00E-03	mg/l		1.93E-08		3.01E-08
Trichloroethane, 1,1,2-	Ingestion of Surface Water	3.95E-04	mg/l		4.20E-08		6.53E-08
Trichlorophenol, 2,4,6-	Ingestion of Surface Water	5.00E-04	mg/l	4.70E-05	2.75E-09	2.19E-04	4.28E-09
Vinyl Chloride	Ingestion of Surface Water	2.50E-03	mg/l		2.66E-09		4.13E-09
		1.00E-03	mg/l		1.84E-07		2.86E-07
TOTAL RISK				8.02E+00	1.25E-03	3.41E+01	1.43E-03

Table F-8. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs due to Inhalation and Ingestion of Caribou at Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Antimony (metallic)	Inhalation of Dust	1.20E-05	mg/m3				
Aroclor 1016	Inhalation of Dust	1.10E-06	mg/m3				
Aroclor 1221	Inhalation of Dust	2.50E-06	mg/m3				
Aroclor 1232	Inhalation of Dust	1.30E-06	mg/m3				
Aroclor 1248	Inhalation of Dust	1.10E-06	mg/m3				
Aroclor-1242	Inhalation of Dust	1.10E-06	mg/m3				
Benzo(k)fluoranthene	Inhalation of Dust	1.20E-05	mg/m3				
Bis(2-ethylhexyl)Phthalate (DE	Inhalation of Dust	6.60E-06	mg/m3				
Bis(Chloroethyl)ether	Inhalation of Dust	6.00E-06	mg/m3		8.34E-08		7.81E-08
Bromodichloromethane	Inhalation of Dust	3.30E-07	mg/m3				
Dibenz(a,h)anthracene	Inhalation of Dust	3.50E-06	mg/m3				
Dichlorobenzene, 1,4-	Inhalation of Dust	4.00E-06	mg/m3	8.19E-07		2.30E-06	
Dichlorobenzidine, 3,3'	Inhalation of Dust	8.90E-06	mg/m3				
Dichloroethene, 1,1-	Inhalation of Dust	6.00E-07	mg/m3		1.26E-09		1.18E-09
Dichloropropene, Cis-1,3-	Inhalation of Dust	3.60E-07	mg/m3				
Dichloropropene, Trans-1,3-	Inhalation of Dust	2.70E-07	mg/m3				
Hexachlorobenzene	Inhalation of Dust	5.20E-06	mg/m3		1.01E-07		9.44E-08
Hexachlorobutadiene	Inhalation of Dust	5.40E-06	mg/m3		5.00E-09		4.69E-09
Hexachloroethane	Inhalation of Dust	6.00E-06	mg/m3		1.01E-09		9.47E-10
Indeno(1,2,3-cd)pyrene	Inhalation of Dust	4.30E-06	mg/m3				
Isophorone	Inhalation of Dust	7.20E-05	mg/m3				
Nitroaniline, 3-	Inhalation of Dust	1.80E-05	mg/m3				
Nitroaniline, 4-	Inhalation of Dust	2.10E-05	mg/m3				
Nitrobenzene	Inhalation of Dust	1.70E-05	mg/m3	1.39E-03		3.91E-03	
Nitrosodi-N-propylamine, N-	Inhalation of Dust	4.20E-06	mg/m3				
Nitrosodiphenylamine, N-	Inhalation of Dust	1.40E-05	mg/m3				
Oxybis(1-chloropropane), 2,2'-	Inhalation of Dust	5.20E-06	mg/m3				
Pentachlorophenol	Inhalation of Dust	5.20E-06	mg/m3				
Tetrachloroethane, 1,1,2,2-	Inhalation of Dust	3.50E-07	mg/m3		8.55E-10		8.01E-10
Toxaphene	Inhalation of Dust	4.00E-06	mg/m3		5.39E-08		5.05E-08
Trichlorophenol, 2,4,6-	Inhalation of Dust	6.60E-06	mg/m3		8.61E-10		8.07E-10
Vinyl Chloride	Inhalation of Dust	4.90E-07	mg/m3		1.77E-09		1.66E-09
Antimony (metallic)	Ingestion of Land Mammals	7.27E-07	mg/kg	4.55E-06		2.12E-05	

Table F-8. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs due to Inhalation and Ingestion of Caribou at Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	ADULT		CHILD	
			HAZARD INDEX	CANCER RISK	HAZARD INDEX	CANCER RISK
Aroclor 1016	Ingestion of Land Mammals	5.61E-06	mg/kg	2.01E-04	9.37E-04	
Aroclor 1221	Ingestion of Land Mammals	2.82E-05	mg/kg			
Aroclor 1232	Ingestion of Land Mammals	1.52E-05	mg/kg			
Aroclor 1248	Ingestion of Land Mammals	6.54E-08	mg/kg			
Aroclor-1242	Ingestion of Land Mammals	4.84E-06	mg/kg			
Benzo(k)fluoranthene	Ingestion of Land Mammals	1.36E-05	mg/kg			
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Land Mammals	5.89E-05	mg/kg	7.38E-06	5.31E-10	8.26E-10
Bis(Chloroethyl)ether	Ingestion of Land Mammals	5.07E-06	mg/kg		3.59E-09	5.59E-09
Bromodichloromethane	Ingestion of Land Mammals	2.04E-08	mg/kg	2.55E-09	8.14E-13	1.19E-08
Dibenz(a,h)anthracene	Ingestion of Land Mammals	7.60E-06	mg/kg			1.27E-12
Dichlorobenzene, 1,4-	Ingestion of Land Mammals	3.51E-05	mg/kg		5.42E-10	8.44E-10
Dichlorobenzidine, 3,3'	Ingestion of Land Mammals	6.67E-05	mg/kg		1.93E-08	3.01E-08
Dichloroethene, 1,1-	Ingestion of Land Mammals	7.73E-07	mg/kg	2.15E-07	2.99E-10	1.00E-06
Hexachlorobenzene	Ingestion of Land Mammals	4.09E-05	mg/kg	1.28E-04	4.21E-08	5.97E-04
Hexachlorobutadiene	Ingestion of Land Mammals	6.44E-05	mg/kg		3.23E-09	5.03E-09
Hexachloroethane	Ingestion of Land Mammals	6.54E-05	mg/kg	1.64E-04	5.90E-10	7.64E-04
Indeno(1,2,3-cd)pyrene	Ingestion of Land Mammals	7.62E-07	mg/kg			9.17E-10
Isophorone	Ingestion of Land Mammals	1.15E-04	mg/kg	1.44E-06	7.04E-11	6.72E-06
Nitroaniline, 3-	Ingestion of Land Mammals	1.09E-06	mg/kg			1.09E-10
Nitroaniline, 4-	Ingestion of Land Mammals	1.27E-06	mg/kg			
Nitrobenzene	Ingestion of Land Mammals	3.08E-05	mg/kg	1.54E-04	7.20E-04	
Nitrosodi-N-propylamine, N-	Ingestion of Land Mammals	4.57E-06	mg/kg		2.06E-08	3.20E-08
Nitrosodiphenylamine, N-	Ingestion of Land Mammals	8.84E-05	mg/kg		2.79E-10	4.34E-10
Oxybis(1-chloropropane), 2,2'-	Ingestion of Land Mammals	3.16E-07	mg/kg			
Pentachlorophenol	Ingestion of Land Mammals	5.58E-05	mg/kg	4.66E-06	4.31E-09	6.71E-09
Tetrachloroethane, 1,1,2,2-	Ingestion of Land Mammals	1.09E-06	mg/kg		1.40E-10	2.18E-10
Toxaphene	Ingestion of Land Mammals	2.98E-05	mg/kg		2.11E-08	3.28E-08
Trichlorophenol, 2,4,6-	Ingestion of Land Mammals	6.41E-05	mg/kg		4.54E-10	7.06E-10
Vinyl Chloride	Ingestion of Land Mammals	1.64E-07	mg/kg		2.01E-10	3.12E-10
Bis(2-ethylhexyl)Phthalate (DE	Inhalation of Outdoor Air	2.32E-04	mg/m3			
Isophorone	Inhalation of Outdoor Air	5.00E-01	mg/m3			
Nitrobenzene	Inhalation of Outdoor Air	8.97E-02	mg/m3	7.34E+00	2.06E+01	
TOTAL RISK			7.35E+00		3.66E-07	2.07E+01
					4.16E-07	

Table F-9. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Antimony (metallic)	Ingestion of Berries	4.08E+00	mg/kg	2.69E+00		1.26E+01	
Aroclor 1016	Ingestion of Berries	8.29E-05	mg/kg	3.12E-04		1.46E-03	
Aroclor 1221	Ingestion of Berries	3.16E-02	mg/kg	1.19E-01	1.65E-05	5.56E-01	2.57E-05
Aroclor 1232	Ingestion of Berries	5.63E-03	mg/kg	2.12E-02	2.94E-06	9.90E-02	4.58E-06
Aroclor 1248	Ingestion of Berries	7.34E-01	mg/kg	2.77E+00	3.83E-04	1.29E+01	5.97E-04
Aroclor-1242	Ingestion of Berries	5.43E-05	mg/kg				
Benzo(k)fluoranthene	Ingestion of Berries	2.16E-05	mg/kg		1.07E-10		1.66E-10
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Berries	3.31E-03	mg/kg	4.37E-05	3.14E-09	2.04E-04	4.89E-09
Bis(Chloroethyl)ether	Ingestion of Berries	4.31E+00	mg/kg		3.22E-04		5.00E-04
Bromodichloromethane	Ingestion of Berries	1.55E-01	mg/kg	2.04E-03	6.52E-07	9.54E-03	1.01E-06
Dibenz(a,h)anthracene	Ingestion of Berries	2.69E-05	mg/kg		1.33E-08		2.07E-08
Dichlorobenzene, 1,4-	Ingestion of Berries	1.19E-01	mg/kg		1.94E-07		3.01E-07
Dichlorobenzidine, 3,3'	Ingestion of Berries	3.75E-01	mg/kg		1.14E-05		1.78E-05
Dichloroethene, 1,1-	Ingestion of Berries	1.95E-01	mg/kg	5.72E-03	7.94E-06	2.67E-02	1.23E-05
Dichloropropene, Cis-1,3-	Ingestion of Berries	1.63E-01	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Berries	1.26E-01	mg/kg				
Hexachlorobenzene	Ingestion of Berries	1.55E-03	mg/kg	5.11E-04	1.68E-07	2.39E-03	2.62E-07
Hexachlorobutadiene	Ingestion of Berries	3.79E-02	mg/kg		2.01E-07		3.12E-07
Hexachloroethane	Ingestion of Berries	8.61E-02	mg/kg	2.27E-02	8.18E-08	1.06E-01	1.27E-07
Indeno(1,2,3-cd)pyrene	Ingestion of Berries	1.87E-07	mg/kg		9.26E-12		1.44E-11
Isophorone	Ingestion of Berries	2.57E+01	mg/kg	3.39E-02	1.66E-06	1.58E-01	2.58E-06
Nitroaniline, 3-	Ingestion of Berries	1.22E+01	mg/kg	1.07E+00		5.01E+00	
Nitroaniline, 4-	Ingestion of Berries	1.43E+01	mg/kg	1.26E+00	5.87E+00		
Nitrobenzene	Ingestion of Berries	4.87E+00	mg/kg	2.57E+00		1.20E+01	
Nitrosodi-N-propylamine, N-	Ingestion of Berries	2.51E+00	mg/kg		1.19E-03		1.85E-03
Nitrosodiphenylamine, N-	Ingestion of Berries	7.35E-01	mg/kg		2.44E-07		3.80E-07
Oxybis(1-chloropropane), 2,2'-	Ingestion of Berries	3.55E+00	mg/kg				
Pentachlorophenol	Ingestion of Berries	6.11E-03	mg/kg	5.37E-05	4.97E-08	2.51E-04	7.74E-08
Tetrachloroethane, 1,1,2,2-	Ingestion of Berries	4.47E-02	mg/kg		6.07E-07		9.44E-07
Toxaphene	Ingestion of Berries	3.25E-02	mg/kg		2.43E-06		3.77E-06
Trichlorophenol, 2,4,6-	Ingestion of Berries	1.47E-01	mg/kg		1.10E-07		1.71E-07
Vinyl Chloride	Ingestion of Berries	3.15E-01	mg/kg		4.06E-05		6.32E-05
Aldrin	Dermal Contact with Sediment	2.00E-04	mg/kg	1.57E-05	5.13E-10	2.89E-05	3.16E-10
Antimony (metallic)	Dermal Contact with Sediment	5.00E+00	mg/kg				
Aroclor 1016	Dermal Contact with Sediment	2.00E-02	mg/kg				
Aroclor 1221	Dermal Contact with Sediment	2.50E-02	mg/kg				
Aroclor 1232	Dermal Contact with Sediment	1.00E-02	mg/kg				
Aroclor 1248	Dermal Contact with Sediment	1.00E-02	mg/kg				

Table F-9. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Aroclor-1242	Dermal Contact with Sediment	1.50E-02	mg/kg				
Benzo(a)anthracene	Dermal Contact with Sediment	2.50E-01	mg/kg		1.95E-07		1.20E-07
Benzo(a)pyrene	Dermal Contact with Sediment	3.00E-01	mg/kg		2.48E-06		1.53E-06
Benzo(b)fluoranthene	Dermal Contact with Sediment	3.00E-01	mg/kg		2.33E-07		1.44E-07
Benzo(k)fluoranthene	Dermal Contact with Sediment	5.50E-01	mg/kg				
Bis(Chloroethyl)ether	Dermal Contact with Sediment	2.50E-01	mg/kg				
Cadmium (food)	Dermal Contact with Sediment	1.00E+00	mg/kg				
Chrysene	Dermal Contact with Sediment	3.00E-01	mg/kg		2.28E-09		1.40E-09
Dibenz(a,h)anthracene	Dermal Contact with Sediment	1.50E-01	mg/kg				
Dichlorobenzidine, 3,3'	Dermal Contact with Sediment	4.00E-01	mg/kg				
Dichloroethene, 1,1-	Dermal Contact with Sediment	2.55E-01	mg/kg				
Dieldrin	Dermal Contact with Sediment	3.00E-04	mg/kg	1.41E-05	2.90E-09	2.60E-05	1.79E-09
Dinitrotoluene, 2,4-	Dermal Contact with Sediment	1.50E-01	mg/kg	1.96E-04		3.62E-04	
Dinitrotoluene, 2,6-	Dermal Contact with Sediment	4.00E-01	mg/kg				
Heptachlor	Dermal Contact with Sediment	2.00E-04	mg/kg				
Hexachlorobenzene	Dermal Contact with Sediment	2.50E-01	mg/kg				
Hexachlorobutadiene	Dermal Contact with Sediment	2.50E-01	mg/kg				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Sediment	2.00E-01	mg/kg				
Nitroaniline, 3-	Dermal Contact with Sediment	8.00E-01	mg/kg				
Nitroaniline, 4-	Dermal Contact with Sediment	9.50E-01	mg/kg				
Nitrosodi-N-propylamine, N-	Dermal Contact with Sediment	2.00E-01	mg/kg				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Sediment	2.50E-01	mg/kg				
Pentachlorophenol	Dermal Contact with Sediment	2.30E-01	mg/kg				
Selenium (and compounds)	Dermal Contact with Sediment	5.00E+00	mg/kg				
Tetrachloroethane, 1,1,2,2-	Dermal Contact with Sediment	2.00E-01	mg/kg				
Toxaphene	Dermal Contact with Sediment	2.00E-02	mg/kg				
Vinyl Chloride	Dermal Contact with Sediment	2.05E-01	mg/kg				
Aldrin	Ingestion of Sediment	2.00E-04	mg/kg	3.13E-06	4.11E-10	2.92E-05	1.28E-09
Antimony (metallic)	Ingestion of Sediment	5.00E+00	mg/kg	5.87E-03		5.48E-02	
Aroclor 1016	Ingestion of Sediment	2.00E-02	mg/kg	1.34E-04		1.25E-03	
Aroclor 1221	Ingestion of Sediment	2.50E-02	mg/kg	1.68E-04		1.57E-03	7.23E-08
Aroclor 1232	Ingestion of Sediment	1.00E-02	mg/kg	6.71E-05		6.26E-04	2.89E-08
Aroclor 1248	Ingestion of Sediment	1.00E-02	mg/kg	6.71E-05		6.26E-04	2.89E-08
Aroclor-1242	Ingestion of Sediment	1.50E-02	mg/kg				
Benzo(a)anthracene	Ingestion of Sediment	2.50E-01	mg/kg		2.20E-08		6.86E-08
Benzo(a)pyrene	Ingestion of Sediment	3.00E-01	mg/kg		2.64E-07		8.23E-07
Benzo(b)fluoranthene	Ingestion of Sediment	3.00E-01	mg/kg		2.64E-08		8.23E-08
Benzo(k)fluoranthene	Ingestion of Sediment	5.50E-01	mg/kg		4.85E-09		1.51E-08

Table F-9. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Bis(Chloroethyl)ether	Ingestion of Sediment	2.50E-01	mg/kg		3.32E-08		1.03E-07
Cadmium (food)	Ingestion of Sediment	1.00E+00	mg/kg	4.70E-04		4.38E-03	
Chrysene	Ingestion of Sediment	3.00E-01	mg/kg		2.64E-10		8.23E-10
Dibenz(a,h)anthracene	Ingestion of Sediment	1.50E-01	mg/kg		1.32E-07		4.11E-07
Dichlorobenzidine, 3,3'	Ingestion of Sediment	4.00E-01	mg/kg		2.17E-08		6.76E-08
Dichloroethene, 1,1-	Ingestion of Sediment	2.55E-01	mg/kg	1.33E-05	1.85E-08	1.24E-04	5.75E-08
Dieldrin	Ingestion of Sediment	3.00E-04	mg/kg	2.82E-06	5.80E-10	2.63E-05	1.80E-09
Dinitrotoluene, 2,4-	Ingestion of Sediment	1.50E-01	mg/kg	3.52E-05		3.29E-04	
Dinitrotoluene, 2,6-	Ingestion of Sediment	4.00E-01	mg/kg	1.88E-04		1.75E-03	
Heptachlor	Ingestion of Sediment	2.00E-04	mg/kg	1.88E-07	1.09E-10	1.75E-06	3.38E-10
Hexachlorobenzene	Ingestion of Sediment	2.50E-01	mg/kg	1.47E-04	4.83E-08	1.37E-03	1.50E-07
Hexachlorobutadiene	Ingestion of Sediment	2.50E-01	mg/kg		2.36E-09		7.33E-09
Indeno(1,2,3-cd)pyrene	Ingestion of Sediment	2.00E-01	mg/kg		1.76E-08		5.49E-08
Nitroaniline, 3-	Ingestion of Sediment	8.00E-01	mg/kg	1.25E-04		1.17E-03	
Nitroaniline, 4-	Ingestion of Sediment	9.50E-01	mg/kg	1.49E-04		1.39E-03	
Nitrosodi-N-propylamine, N-	Ingestion of Sediment	2.00E-01	mg/kg		1.69E-07		5.26E-07
Oxybis(1-chloropropane), 2,2'-	Ingestion of Sediment	2.50E-01	mg/kg				
Pentachlorophenol	Ingestion of Sediment	2.30E-01	mg/kg	3.60E-06	3.33E-09	3.36E-05	1.04E-08
Selenium (and compounds)	Ingestion of Sediment	5.00E+00	mg/kg	4.70E-04		4.38E-03	
Tetrachloroethane, 1,1,2,2-	Ingestion of Sediment	2.00E-01	mg/kg		4.83E-09		1.50E-08
Toxaphene	Ingestion of Sediment	2.00E-02	mg/kg		2.66E-09		8.27E-09
Vinyl Chloride	Ingestion of Sediment	2.05E-01	mg/kg		4.70E-08		1.46E-07
Antimony (metallic)	Dermal Contact with Soil	5.00E+00	mg/kg				
Aroclor 1016	Dermal Contact with Soil	9.00E-01	mg/kg				
Aroclor 1221	Dermal Contact with Soil	2.10E+00	mg/kg				
Aroclor 1232	Dermal Contact with Soil	1.05E+00	mg/kg				
Aroclor 1248	Dermal Contact with Soil	9.00E-01	mg/kg				
Aroclor-1242	Dermal Contact with Soil	9.00E-01	mg/kg				
Benzo(k)fluoranthene	Dermal Contact with Soil	1.00E+01	mg/kg				
Bis(2-ethylhexyl)Phthalate (DE	Dermal Contact with Soil	5.50E+00	mg/kg	1.17E-03	2.56E-08	2.17E-03	1.58E-08
Bis(Chloroethyl)ether	Dermal Contact with Soil	5.00E+00	mg/kg				
Bromodichloromethane	Dermal Contact with Soil	1.90E-01	mg/kg				
Dibenz(a,h)anthracene	Dermal Contact with Soil	2.95E+00	mg/kg				
Dichlorobenzene, 1,4-	Dermal Contact with Soil	3.35E+00	mg/kg				
Dichlorobenzidine, 3,3'	Dermal Contact with Soil	7.50E+00	mg/kg				
Dichloroethene, 1,1-	Dermal Contact with Soil	3.40E-01	mg/kg				
Dichloropropene, Cis-1,3-	Dermal Contact with Soil	2.00E-01	mg/kg				
Dichloropropene, Trans-1,3-	Dermal Contact with Soil	1.55E-01	mg/kg				

Table F-9. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Hexachlorobenzene	Dermal Contact with Soil	4.35E+00	mg/kg				
Hexachlorobutadiene	Dermal Contact with Soil	4.50E+00	mg/kg				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Soil	3.60E+00	mg/kg				
Isophorone	Dermal Contact with Soil	6.00E+01	mg/kg	3.79E-04	1.60E-08	7.00E-04	9.86E-09
Nitroaniline, 3-	Dermal Contact with Soil	1.50E+01	mg/kg				
Nitroaniline, 4-	Dermal Contact with Soil	1.75E+01	mg/kg				
Nitrobenzene	Dermal Contact with Soil	1.40E+01	mg/kg				
Nitrosodi-N-propylamine, N-	Dermal Contact with Soil	3.55E+00	mg/kg				
Nitrosodiphenylamine, N-	Dermal Contact with Soil	1.15E+01	mg/kg				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Soil	4.35E+00	mg/kg				
Pentachlorophenol	Dermal Contact with Soil	4.40E+00	mg/kg				
Tetrachloroethane, 1,1,2,2-	Dermal Contact with Soil	2.65E-01	mg/kg				
Toxaphene	Dermal Contact with Soil	6.50E-01	mg/kg				
Trichlorophenol, 2,4,6-	Dermal Contact with Soil	5.50E+00	mg/kg				
Vinyl Chloride	Dermal Contact with Soil	2.80E-01	mg/kg				
Antimony (metallic)	Ingestion of Soil	5.00E+00	mg/kg	5.87E-03		5.48E-02	
Aroclor 1016	Ingestion of Soil	9.00E-01	mg/kg	6.04E-03		5.64E-02	
Aroclor 1221	Ingestion of Soil	2.10E+00	mg/kg	1.41E-02	1.95E-06	1.32E-01	6.08E-06
Aroclor 1232	Ingestion of Soil	1.05E+00	mg/kg	7.05E-03	9.76E-07	6.58E-02	3.04E-06
Aroclor 1248	Ingestion of Soil	9.00E-01	mg/kg	6.04E-03	8.37E-07	5.64E-02	2.60E-06
Aroclor-1242	Ingestion of Soil	9.00E-01	mg/kg				
Benzo(k)fluoranthene	Ingestion of Soil	1.00E+01	mg/kg		8.82E-08		2.74E-07
Bis(2-ethylhexyl)phthalate (DE	Ingestion of Soil	5.50E+00	mg/kg	1.29E-04	9.30E-09	1.21E-03	2.89E-08
Bis(Chloroethyl)ether	Ingestion of Soil	5.00E+00	mg/kg		6.64E-07		2.07E-06
Bromodichloromethane	Ingestion of Soil	1.90E-01	mg/kg	4.46E-06	1.42E-09	4.16E-05	4.43E-09
Dibenz(a,h)anthracene	Ingestion of Soil	2.95E+00	mg/kg		2.60E-06		8.09E-06
Dichlorobenzene, 1,4-	Ingestion of Soil	3.35E+00	mg/kg		9.71E-09		3.02E-08
Dichlorobenzidine, 3,3'	Ingestion of Soil	7.50E+00	mg/kg		4.08E-07		1.27E-06
Dichloroethene, 1,1-	Ingestion of Soil	3.40E-01	mg/kg	1.77E-05	2.46E-08	1.66E-04	7.66E-08
Dichloropropene, Cis-1,3-	Ingestion of Soil	2.00E-01	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Soil	1.55E-01	mg/kg				
Hexachlorobenzene	Ingestion of Soil	4.35E+00	mg/kg	2.55E-03	8.41E-07	2.38E-02	2.62E-06
Hexachlorobutadiene	Ingestion of Soil	4.50E+00	mg/kg		4.24E-08		1.32E-07
Indeno(1,2,3-cd)pyrene	Ingestion of Soil	3.60E+00	mg/kg		3.17E-07		9.87E-07
Isophorone	Ingestion of Soil	6.00E+01	mg/kg	1.41E-04	6.88E-09	1.32E-03	2.14E-08
Nitroaniline, 3-	Ingestion of Soil	1.50E+01	mg/kg	2.35E-03		2.19E-02	
Nitroaniline, 4-	Ingestion of Soil	1.75E+01	mg/kg	2.74E-03		2.56E-02	
Nitrobenzene	Ingestion of Soil	1.40E+01	mg/kg	1.32E-02		1.23E-01	

Table F-9. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Nitrosodi-N-propylamine, N-	Ingestion of Soil	3.55E+00	mg/kg		3.00E-06		9.34E-06
Nitrosodiphenylamine, N-	Ingestion of Soil	1.15E+01	mg/kg		6.81E-09		2.12E-08
Oxybis(1-chloropropane), 2,2'-	Ingestion of Soil	4.35E+00	mg/kg				
Pentachlorophenol	Ingestion of Soil	4.40E+00	mg/kg				
Tetrachloroethane, 1,1,2,2-	Ingestion of Soil	2.65E-01	mg/kg	6.89E-05	6.38E-08	6.43E-04	1.98E-07
Toxaphene	Ingestion of Soil	6.50E-01	mg/kg		6.40E-09		1.99E-08
Trichlorophenol, 2,4,6-	Ingestion of Soil	5.50E+00	mg/kg		8.64E-08		2.69E-07
Vinyl Chloride	Ingestion of Soil	2.80E-01	mg/kg		7.31E-09		2.27E-08
Aroclor 1016	Dermal Contact with Surface Water	4.50E-04	mg/l		6.43E-08		2.00E-07
Aroclor 1221	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1232	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1248	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1254	Dermal Contact with Surface Water	5.00E-04	mg/l				
Aroclor 1260	Dermal Contact with Surface Water	5.00E-04	mg/l	7.46E-01	1.03E-04	3.44E-01	1.59E-05
Aroclor-1242	Dermal Contact with Surface Water	3.50E-04	mg/l				
Arsenic (inorganic)	Dermal Contact with Surface Water	5.00E-05	mg/l				
Benzene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Benzo(a)anthracene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.07E-05		3.20E-06
Benzo(a)pyrene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.20E-04		3.39E-05
Benzo(b)fluoranthene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.07E-05		3.20E-06
Benzo(k)fluoranthene	Dermal Contact with Surface Water	1.50E-03	mg/l				
Bis(Chloroethyl)ether	Dermal Contact with Surface Water	3.00E-03	mg/l				
Bromodichloromethane	Dermal Contact with Surface Water	1.00E-03	mg/l				
Bromomethane	Dermal Contact with Surface Water	1.00E-03	mg/l				
Chrysene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.03E-07		3.12E-08
Dibenz(a,h)anthracene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichlorobenzidine, 3,3'	Dermal Contact with Surface Water	3.50E-03	mg/l				
Dichloroethane, 1,2-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichloroethene, 1,1-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichloropropane, 1,2-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichloropropene, Cis-1,3-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Dichloropropene, Trans-1,3-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dinitrophenol, 2,4-	Dermal Contact with Surface Water	1.50E-02	mg/l				
Dinitrotoluene, 2,4-	Dermal Contact with Surface Water	2.00E-03	mg/l	1.04E-01		4.82E-02	
Dinitrotoluene, 2,6-	Dermal Contact with Surface Water	2.50E-03	mg/l				
Hexachlorobenzene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Hexachlorobutadiene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Surface Water	1.00E-03	mg/l				

Table F-9. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Nitroaniline, 2-	Dermal Contact with Surface Water	2.00E-03	mg/l				
Nitroaniline, 3-	Dermal Contact with Surface Water	1.00E-02	mg/l				
Nitroaniline, 4-	Dermal Contact with Surface Water	7.00E-03	mg/l				
Nitrosodi-N-propylamine, N-	Dermal Contact with Surface Water	2.00E-03	mg/l				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Pentachlorophenol	Dermal Contact with Surface Water	6.00E-03	mg/l				
Tetrachloroethane, 1,1,2,2-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Toxaphene	Dermal Contact with Surface Water	3.95E-04	mg/l				
Trichloroethane, 1,1,2-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Trichlorophenol, 2,4,6-	Dermal Contact with Surface Water	2.50E-03	mg/l				
Vinyl Chloride	Dermal Contact with Surface Water	1.00E-03	mg/l				
Aroclor 1016	Ingestion of Surface Water	4.50E-04	mg/l	2.42E-03		1.13E-02	
Aroclor 1221	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1232	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1248	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1254	Ingestion of Surface Water	5.00E-04	mg/l	9.39E-03		4.38E-02	
Aroclor 1260	Ingestion of Surface Water	5.00E-04	mg/l	2.68E-03	3.72E-07	1.25E-02	5.79E-07
Aroclor-1242	Ingestion of Surface Water	3.50E-04	mg/l				
Arsenic (inorganic)	Ingestion of Surface Water	5.00E-05	mg/l	6.26E-05	8.45E-09	2.92E-04	1.32E-08
Benzene	Ingestion of Surface Water	1.00E-03	mg/l		2.80E-09		4.36E-09
Benzo(a)anthracene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Benzo(a)pyrene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-07		1.10E-06
Benzo(b)fluoranthene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Benzo(k)fluoranthene	Ingestion of Surface Water	1.50E-03	mg/l		1.06E-08		1.65E-08
Bis(Chloroethyl)ether	Ingestion of Surface Water	3.00E-03	mg/l		3.19E-07		4.96E-07
Bromodichloromethane	Ingestion of Surface Water	1.00E-03	mg/l	1.88E-05	5.99E-09	8.77E-05	9.32E-09
Bromomethane	Ingestion of Surface Water	1.00E-03	mg/l	2.68E-04		1.25E-03	
Chrysene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-10		1.10E-09
Dibenz(a,h)anthracene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-07		1.10E-06
Dichlorobenzidine, 3,3'	Ingestion of Surface Water	3.50E-03	mg/l		1.52E-07		2.37E-07
Dichloroethane, 1,2-	Ingestion of Surface Water	1.00E-03	mg/l		8.79E-09		1.37E-08
Dichloroethene, 1,1-	Ingestion of Surface Water	1.00E-03	mg/l		5.80E-08	1.95E-04	9.02E-08
Dichloropropane, 1,2-	Ingestion of Surface Water	1.00E-03	mg/l	4.17E-05	6.57E-09		1.02E-08
Dichloropropene, Cis-1,3-	Ingestion of Surface Water	5.00E-04	mg/l				
Dichloropropene, Trans-1,3-	Ingestion of Surface Water	1.00E-03	mg/l				
Dinitrophenol, 2,4-	Ingestion of Surface Water	1.50E-02	mg/l	2.82E-03		1.32E-02	
Dinitrotoluene, 2,4-	Ingestion of Surface Water	2.00E-03	mg/l	3.76E-04		1.75E-03	
Dinitrotoluene, 2,6-	Ingestion of Surface Water	2.50E-03	mg/l	9.39E-04		4.38E-03	

Table F-9. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the White Alice area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Hexachlorobenzene	Ingestion of Surface Water	1.00E-03	mg/l	4.70E-04	1.55E-07	2.19E-03	2.40E-07
Hexachlorobutadiene	Ingestion of Surface Water	1.00E-03	mg/l		7.54E-09		1.17E-08
Indeno(1,2,3-cd)pyrene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Nitroaniline, 2-	Ingestion of Surface Water	2.00E-03	mg/l	1.25E-02		5.84E-02	
Nitroaniline, 3-	Ingestion of Surface Water	1.00E-02	mg/l	1.25E-03		5.84E-03	
Nitroaniline, 4-	Ingestion of Surface Water	7.00E-03	mg/l	8.77E-04		4.09E-03	
Nitrosodi-N-propylamine, N-	Ingestion of Surface Water	2.00E-03	mg/l		1.35E-06		2.10E-06
Oxybis(1-chloropropane), 2,2'-	Ingestion of Surface Water	5.00E-04	mg/l				
Pentachlorophenol	Ingestion of Surface Water	6.00E-03	mg/l	7.51E-05	6.96E-08	3.51E-04	1.08E-07
Tetrachloroethane, 1,1,2,2-	Ingestion of Surface Water	1.00E-03	mg/l		1.93E-08		3.01E-08
Toxaphene	Ingestion of Surface Water	3.95E-04	mg/l		4.20E-08		6.53E-08
Trichloroethane, 1,1,2-	Ingestion of Surface Water	5.00E-04	mg/l	4.70E-05	2.75E-09	2.19E-04	4.28E-09
Trichlorophenol, 2,4,6-	Ingestion of Surface Water	2.50E-03	mg/l		2.66E-09		4.13E-09
Vinyl Chloride	Ingestion of Surface Water	1.00E-03	mg/l		1.84E-07		2.86E-07
TOTAL RISK				1.15E+01	2.37E-03	5.05E+01	3.19E-03

Table F-10. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Western Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Antimony (metallic)	Ingestion of Berries	4.08E+00	mg/kg	2.69E+00		1.26E+01	
Aroclor 1016	Ingestion of Berries	8.29E-05	mg/kg	3.12E-04		1.46E-03	
Aroclor 1221	Ingestion of Berries	1.58E-02	mg/kg	5.96E-02	8.25E-06	2.78E-01	1.28E-05
Aroclor 1232	Ingestion of Berries	2.44E-03	mg/kg	9.20E-03	1.27E-06	4.29E-02	1.98E-06
Aroclor 1248	Ingestion of Berries	3.38E-01	mg/kg	1.27E+00	1.77E-04	5.95E+00	2.75E-04
Aroclor-1242	Ingestion of Berries	3.32E-05	mg/kg				
Benzo(k)fluoranthene	Ingestion of Berries	1.08E-05	mg/kg		5.35E-11		8.32E-11
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Berries	1.69E-03	mg/kg	2.23E-05	1.61E-09	1.04E-04	2.50E-09
Bis(Chloroethyl)ether	Ingestion of Berries	2.37E+00	mg/kg		1.77E-04		2.75E-04
Bromodichloromethane	Ingestion of Berries	2.28E-01	mg/kg	3.01E-03	9.59E-07	1.40E-02	1.49E-06
Dibenz(a,h)anthracene	Ingestion of Berries	1.42E-05	mg/kg		7.03E-09		1.09E-08
Dichlorobenzene, 1,4-	Ingestion of Berries	6.21E-02	mg/kg		1.01E-07		1.57E-07
Dichlorobenzidine, 3,3'	Ingestion of Berries	2.02E-01	mg/kg		6.17E-06		9.59E-06
Dichloroethene, 1,1-	Ingestion of Berries	2.87E-01	mg/kg		1.17E-05	3.93E-02	1.82E-05
Dichloropropene, Cis-1,3-	Ingestion of Berries	2.45E-01	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Berries	1.87E-01	mg/kg				
Hexachlorobenzene	Ingestion of Berries	8.22E-04	mg/kg	2.71E-04	8.92E-08	1.27E-03	1.39E-07
Hexachlorobutadiene	Ingestion of Berries	1.98E-02	mg/kg		1.05E-07		1.63E-07
Hexachloroethane	Ingestion of Berries	4.74E-02	mg/kg	1.25E-02	4.50E-08	5.84E-02	7.00E-08
Indeno(1,2,3-cd)pyrene	Ingestion of Berries	9.86E-08	mg/kg		4.88E-12		7.60E-12
Isophorone	Ingestion of Berries	3.85E+00	mg/kg	5.08E-03	2.48E-07	2.37E-02	3.86E-07
Nitroaniline, 3-	Ingestion of Berries	6.52E+00	mg/kg	5.73E-01		2.68E+00	
Nitroaniline, 4-	Ingestion of Berries	7.74E+00	mg/kg	6.81E-01		3.18E+00	
Nitrobenzene	Ingestion of Berries	1.13E+00	mg/kg	5.96E-01		2.78E+00	
Nitrosodi-N-propylamine, N-	Ingestion of Berries	1.31E+00	mg/kg		6.22E-04		9.68E-04
Nitrosodiphenylamine, N-	Ingestion of Berries	3.83E-01	mg/kg		1.27E-07		1.98E-07
Oxybis(1-chloropropane), 2,2'-	Ingestion of Berries	1.87E+00	mg/kg				
Pentachlorophenol	Ingestion of Berries	3.19E-03	mg/kg	2.81E-05	2.60E-08	1.31E-04	4.04E-08
Toxaphene	Ingestion of Berries	1.67E-01	mg/kg		1.25E-05		1.94E-05
Trichlorophenol, 2,4,6-	Ingestion of Berries	8.00E-02	mg/kg		5.97E-08		9.29E-08
Vinyl Chloride	Ingestion of Berries	4.61E-01	mg/kg		5.94E-05		9.24E-05
Aldrin	Dermal Contact with Sediment	2.30E-04	mg/kg	1.80E-05	5.90E-10	3.33E-05	3.64E-10
Aroclor 1016	Dermal Contact with Sediment	3.50E-02	mg/kg				
Aroclor 1221	Dermal Contact with Sediment	4.00E-02	mg/kg				
Aroclor 1232	Dermal Contact with Sediment	1.50E-02	mg/kg				
Aroclor 1248	Dermal Contact with Sediment	1.00E-02	mg/kg				
Aroclor-1242	Dermal Contact with Sediment	2.00E-02	mg/kg				

Table F-10. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Western Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Benzo(a)anthracene	Dermal Contact with Sediment	1.50E-01	mg/kg		1.17E-07		7.19E-08
Benzo(a)pyrene	Dermal Contact with Sediment	1.50E-01	mg/kg		1.24E-06		7.64E-07
Benzo(b)fluoranthene	Dermal Contact with Sediment	1.50E-01	mg/kg		1.17E-07		7.19E-08
Benzo(k)fluoranthene	Dermal Contact with Sediment	2.50E-01	mg/kg				
Bis(Chloroethyl)ether	Dermal Contact with Sediment	1.50E-01	mg/kg				
Chrysene	Dermal Contact with Sediment	1.50E-01	mg/kg		1.14E-09		7.02E-10
Dibenz(a,h)anthracene	Dermal Contact with Sediment	1.00E-01	mg/kg				
Dichlorobenzidine, 3,3'	Dermal Contact with Sediment	2.00E-01	mg/kg				
Dichloroethene, 1,1-	Dermal Contact with Sediment	3.50E-03	mg/kg				
Dieldrin	Dermal Contact with Sediment	4.50E-04	mg/kg				
Dinitrotoluene, 2,4-	Dermal Contact with Sediment	1.50E-01	mg/kg	2.11E-05	4.35E-09	3.91E-05	2.68E-09
Dinitrotoluene, 2,6-	Dermal Contact with Sediment	2.00E-01	mg/kg	1.96E-04		3.62E-04	
Heptachlor	Dermal Contact with Sediment	3.50E-04	mg/kg				
Hexachlorobenzene	Dermal Contact with Sediment	1.00E-01	mg/kg				
Hexachlorobutadiene	Dermal Contact with Sediment	1.00E-01	mg/kg				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Sediment	1.00E-01	mg/kg				
Nitroaniline, 3-	Dermal Contact with Sediment	5.50E-01	mg/kg				
Nitroaniline, 4-	Dermal Contact with Sediment	4.85E-01	mg/kg				
Nitrosodi-N-propylamine, N-	Dermal Contact with Sediment	1.00E-01	mg/kg				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Sediment	1.00E-01	mg/kg				
Pentachlorophenol	Dermal Contact with Sediment	1.20E-01	mg/kg				
Toxaphene	Dermal Contact with Sediment	2.50E-02	mg/kg				
Vinyl Chloride	Dermal Contact with Sediment	3.00E-03	mg/kg				
Aldrin	Ingestion of Sediment	2.30E-04	mg/kg	3.60E-06	4.72E-10	3.36E-05	1.47E-09
Aroclor 1016	Ingestion of Sediment	3.50E-02	mg/kg	2.35E-04		2.19E-03	
Aroclor 1221	Ingestion of Sediment	4.00E-02	mg/kg	2.68E-04		2.50E-03	
Aroclor 1232	Ingestion of Sediment	1.50E-02	mg/kg	1.01E-04	1.39E-08	9.39E-04	1.16E-07
Aroclor 1248	Ingestion of Sediment	1.00E-02	mg/kg	6.71E-05	9.30E-09	6.26E-04	4.34E-08
Aroclor-1242	Ingestion of Sediment	2.00E-02	mg/kg				2.89E-08
Benzo(a)anthracene	Ingestion of Sediment	1.50E-01	mg/kg		1.32E-08		4.11E-08
Benzo(a)pyrene	Ingestion of Sediment	1.50E-01	mg/kg		1.32E-07		4.11E-07
Benzo(b)fluoranthene	Ingestion of Sediment	1.50E-01	mg/kg		1.32E-08		4.11E-08
Benzo(k)fluoranthene	Ingestion of Sediment	2.50E-01	mg/kg		2.20E-09		6.86E-09
Bis(Chloroethyl)ether	Ingestion of Sediment	1.50E-01	mg/kg		1.99E-08		6.20E-08
Chrysene	Ingestion of Sediment	1.50E-01	mg/kg		1.32E-10		4.11E-10
Dibenz(a,h)anthracene	Ingestion of Sediment	1.00E-01	mg/kg		8.82E-08		2.74E-07
Dichlorobenzidine, 3,3'	Ingestion of Sediment	2.00E-01	mg/kg		1.09E-08		3.38E-08

Table F-10. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Western Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Dichloroethene, 1,1-	Ingestion of Sediment	3.50E-03	mg/kg	1.83E-07	2.54E-10	1.70E-06	7.89E-10
Dieldrin	Ingestion of Sediment	4.50E-04	mg/kg	4.23E-06	8.70E-10	3.95E-05	2.71E-09
Dinitrotoluene, 2,4-	Ingestion of Sediment	1.50E-01	mg/kg	3.52E-05		3.29E-04	
Dinitrotoluene, 2,6-	Ingestion of Sediment	2.00E-01	mg/kg	9.39E-05		8.77E-04	
Heptachlor	Ingestion of Sediment	3.50E-04	mg/kg	3.29E-07	1.90E-10	3.07E-06	5.92E-10
Hexachlorobenzene	Ingestion of Sediment	1.00E-01	mg/kg	5.87E-05	1.93E-08	5.48E-04	6.01E-08
Hexachlorobutadiene	Ingestion of Sediment	1.00E-01	mg/kg		9.42E-10		2.93E-09
Indeno(1,2,3-cd)pyrene	Ingestion of Sediment	1.00E-01	mg/kg		8.82E-09		2.74E-08
Nitroaniline, 3-	Ingestion of Sediment	5.50E-01	mg/kg	8.61E-05		8.04E-04	
Nitroaniline, 4-	Ingestion of Sediment	4.85E-01	mg/kg	7.59E-05		7.09E-04	
Nitrosodi-N-propylamine, N-	Ingestion of Sediment	1.00E-01	mg/kg		8.45E-08		2.63E-07
Oxybis(1-chloropropane), 2,2'-	Ingestion of Sediment	1.00E-01	mg/kg				
Pentachlorophenol	Ingestion of Sediment	1.20E-01	mg/kg	1.88E-06	1.74E-09	1.75E-05	5.41E-09
Toxaphene	Ingestion of Sediment	2.50E-02	mg/kg		3.32E-09		1.03E-08
Vinyl Chloride	Ingestion of Sediment	3.00E-03	mg/kg		6.88E-10		2.14E-09
Antimony (metallic)	Dermal Contact with Soil	5.00E+00	mg/kg				
Aroclor 1016	Dermal Contact with Soil	9.00E-01	mg/kg				
Aroclor 1221	Dermal Contact with Soil	1.05E+00	mg/kg				
Aroclor 1232	Dermal Contact with Soil	4.55E-01	mg/kg				
Aroclor 1248	Dermal Contact with Soil	4.15E-01	mg/kg				
Aroclor-1242	Dermal Contact with Soil	5.50E-01	mg/kg				
Benzo(k)fluoranthene	Dermal Contact with Soil	5.00E+00	mg/kg				
Bis(2-ethylhexyl)Phthalate (DE	Dermal Contact with Soil	2.80E+00	mg/kg	5.98E-04	1.30E-08	1.10E-03	8.02E-09
Bis(Chloroethyl)ether	Dermal Contact with Soil	2.75E+00	mg/kg				
Bromodichloromethane	Dermal Contact with Soil	2.80E-01	mg/kg				
Dibenz(a,h)anthracene	Dermal Contact with Soil	1.55E+00	mg/kg				
Dichlorobenzene, 1,4-	Dermal Contact with Soil	1.75E+00	mg/kg				
Dichlorobenzidine, 3,3'	Dermal Contact with Soil	4.05E+00	mg/kg				
Dichloroethene, 1,1-	Dermal Contact with Soil	5.00E-01	mg/kg				
Dichloropropene, Cis-1,3-	Dermal Contact with Soil	3.00E-01	mg/kg				
Dichloropropene, Trans-1,3-	Dermal Contact with Soil	2.30E-01	mg/kg				
Hexachlorobenzene	Dermal Contact with Soil	2.30E+00	mg/kg				
Hexachlorobutadiene	Dermal Contact with Soil	2.35E+00	mg/kg				
Hexachloroethane	Dermal Contact with Soil	2.75E+00	mg/kg				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Soil	1.90E+00	mg/kg				
Isophorone	Dermal Contact with Soil	9.00E+00	mg/kg	5.68E-05	2.40E-09	1.05E-04	1.48E-09
Nitroaniline, 3-	Dermal Contact with Soil	8.00E+00	mg/kg				

Table F-10. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Western Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Nitroaniline, 4-	Dermal Contact with Soil	9.50E+00	mg/kg				
Nitrobenzene	Dermal Contact with Soil	3.25E+00	mg/kg				
Nitrosodi-N-propylamine, N-	Dermal Contact with Soil	1.85E+00	mg/kg				
Nitrosodiphenylamine, N-	Dermal Contact with Soil	6.00E+00	mg/kg				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Soil	2.30E+00	mg/kg				
Pentachlorophenol	Dermal Contact with Soil	2.30E+00	mg/kg				
Toxaphene	Dermal Contact with Soil	3.35E+00	mg/kg				
Vinyl Chloride	Dermal Contact with Soil	4.10E-01	mg/kg				
Antimony (metallic)	Ingestion of Soil	5.00E+00	mg/kg	5.87E-03		5.48E-02	
Aroclor 1016	Ingestion of Soil	9.00E-01	mg/kg	6.04E-03		5.64E-02	
Aroclor 1221	Ingestion of Soil	1.05E+00	mg/kg	7.05E-03	9.76E-07	6.58E-02	3.04E-06
Aroclor 1232	Ingestion of Soil	4.55E-01	mg/kg	3.05E-03	4.23E-07	2.85E-02	1.32E-06
Aroclor 1248	Ingestion of Soil	4.15E-01	mg/kg	2.78E-03	3.86E-07	2.60E-02	1.20E-06
Aroclor-1242	Ingestion of Soil	5.50E-01	mg/kg				
Benzo(k)fluoranthene	Ingestion of Soil	5.00E+00	mg/kg		4.41E-08		1.37E-07
Bis(2-ethylhexyl)Phthalate (DE	Ingestion of Soil	2.80E+00	mg/kg	6.58E-05	4.73E-09	6.14E-04	1.47E-08
Bis(Chloroethyl)ether	Ingestion of Soil	2.75E+00	mg/kg		3.65E-07		1.14E-06
Bromodichloromethane	Ingestion of Soil	2.80E-01	mg/kg	6.58E-06	2.10E-09	6.14E-05	6.52E-09
Dibenz(a,h)anthracene	Ingestion of Soil	1.55E+00	mg/kg		1.37E-06		4.25E-06
Dichlorobenzene, 1,4-	Ingestion of Soil	1.75E+00	mg/kg		5.07E-09		1.58E-08
Dichlorobenzidine, 3,3'	Ingestion of Soil	4.05E+00	mg/kg		2.20E-07		6.85E-07
Dichloroethene, 1,1-	Ingestion of Soil	5.00E-01	mg/kg	2.61E-05	3.62E-08	2.44E-04	1.13E-07
Dichloropropene, Cis-1,3-	Ingestion of Soil	3.00E-01	mg/kg				
Dichloropropene, Trans-1,3-	Ingestion of Soil	2.30E-01	mg/kg				
Hexachlorobenzene	Ingestion of Soil	2.30E+00	mg/kg	1.35E-03	4.44E-07	1.26E-02	1.38E-06
Hexachlorobutadiene	Ingestion of Soil	2.35E+00	mg/kg		2.21E-08		6.89E-08
Hexachloroethane	Ingestion of Soil	2.75E+00	mg/kg	1.29E-03	4.65E-09	1.21E-02	1.45E-08
Indeno(1,2,3-cd)pyrene	Ingestion of Soil	1.90E+00	mg/kg		1.68E-07		5.21E-07
Isophorone	Ingestion of Soil	9.00E+00	mg/kg	2.11E-05	1.03E-09	1.97E-04	3.21E-09
Nitroaniline, 3-	Ingestion of Soil	8.00E+00	mg/kg	1.25E-03		1.17E-02	
Nitroaniline, 4-	Ingestion of Soil	9.50E+00	mg/kg	1.49E-03		1.39E-02	
Nitrobenzene	Ingestion of Soil	3.25E+00	mg/kg	3.05E-03		2.85E-02	
Nitrosodi-N-propylamine, N-	Ingestion of Soil	1.85E+00	mg/kg		1.56E-06		4.87E-06
Nitrosodiphenylamine, N-	Ingestion of Soil	6.00E+00	mg/kg		3.55E-09		1.10E-08
Oxybis(1-chloropropane), 2,2'-	Ingestion of Soil	2.30E+00	mg/kg				
Pentachlorophenol	Ingestion of Soil	2.30E+00	mg/kg	3.60E-05	3.33E-08	3.36E-04	1.04E-07
Toxaphene	Ingestion of Soil	3.35E+00	mg/kg		4.45E-07		1.38E-06

Table F-10. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Western Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Vinyl Chloride	Ingestion of Soil	4.10E-01	mg/kg		9.41E-08		2.93E-07
Aroclor 1016	Dermal Contact with Surface Water	4.50E-04	mg/l				
Aroclor 1221	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1232	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1248	Dermal Contact with Surface Water	4.00E-04	mg/l				
Aroclor 1254	Dermal Contact with Surface Water	5.00E-04	mg/l				
Aroclor 1260	Dermal Contact with Surface Water	5.00E-04	mg/l	7.46E-01	1.03E-04	3.44E-01	1.59E-05
Aroclor-1242	Dermal Contact with Surface Water	3.50E-04	mg/l				
Benzene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Benzo(a)anthracene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.07E-05		3.20E-06
Benzo(a)pyrene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.20E-04		3.39E-05
Benzo(b)fluoranthene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.07E-05		3.20E-06
Benzo(k)fluoranthene	Dermal Contact with Surface Water	1.50E-03	mg/l				
Bis(Chloroethyl)ether	Dermal Contact with Surface Water	3.00E-03	mg/l				
Bromodichloromethane	Dermal Contact with Surface Water	1.00E-03	mg/l				
Bromomethane	Dermal Contact with Surface Water	1.00E-03	mg/l				
Chrysene	Dermal Contact with Surface Water	1.00E-03	mg/l		2.03E-07		3.12E-08
Dibenz(a,h)anthracene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichlorobenzidine, 3,3'	Dermal Contact with Surface Water	3.50E-03	mg/l				
Dichloroethane, 1,2-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichloroethene, 1,1-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichloropropane, 1,2-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dichloropropene, Cis-1,3-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Dichloropropene, Trans-1,3-	Dermal Contact with Surface Water	1.00E-03	mg/l				
Dinitrophenol, 2,4-	Dermal Contact with Surface Water	1.50E-02	mg/l	1.04E-01		4.82E-02	
Dinitrotoluene, 2,4-	Dermal Contact with Surface Water	2.00E-03	mg/l				
Dinitrotoluene, 2,6-	Dermal Contact with Surface Water	2.50E-03	mg/l				
Hexachlorobenzene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Hexachlorobutadiene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Indeno(1,2,3-cd)pyrene	Dermal Contact with Surface Water	1.00E-03	mg/l				
Nitroaniline, 2-	Dermal Contact with Surface Water	2.00E-03	mg/l				
Nitroaniline, 3-	Dermal Contact with Surface Water	1.00E-02	mg/l				
Nitroaniline, 4-	Dermal Contact with Surface Water	7.00E-03	mg/l				
Nitrosodi-N-propylamine, N-	Dermal Contact with Surface Water	2.00E-03	mg/l				
Oxybis(1-chloropropane), 2,2'-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Pentachlorophenol	Dermal Contact with Surface Water	6.00E-03	mg/l				
Toxaphene	Dermal Contact with Surface Water	3.95E-04	mg/l				

Table F-10. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Western Drainage area, Kotzebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Trichloroethane, 1,1,2-	Dermal Contact with Surface Water	5.00E-04	mg/l				
Trichlorophenol, 2,4,6-	Dermal Contact with Surface Water	2.50E-03	mg/l				
Vinyl Chloride	Dermal Contact with Surface Water	1.00E-03	mg/l				
Aroclor 1016	Ingestion of Surface Water	4.50E-04	mg/l	2.42E-03		1.13E-02	
Aroclor 1221	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1232	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1248	Ingestion of Surface Water	4.00E-04	mg/l	2.15E-03	2.98E-07	1.00E-02	4.63E-07
Aroclor 1254	Ingestion of Surface Water	5.00E-04	mg/l	9.39E-03		4.38E-02	
Aroclor 1260	Ingestion of Surface Water	5.00E-04	mg/l	2.68E-03	3.72E-07	1.25E-02	5.79E-07
Aroclor-1242	Ingestion of Surface Water	3.50E-04	mg/l				
Benzene	Ingestion of Surface Water	1.00E-03	mg/l		2.80E-09		4.36E-09
Benzo(a)anthracene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Benzo(a)pyrene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-07		1.10E-06
Benzo(b)fluoranthene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Benzo(k)fluoranthene	Ingestion of Surface Water	1.50E-03	mg/l		1.06E-08		1.65E-08
Bis(Chloroethyl)ether	Ingestion of Surface Water	3.00E-03	mg/l		3.19E-07		4.96E-07
Bromodichloromethane	Ingestion of Surface Water	1.00E-03	mg/l	1.88E-05	5.99E-09	8.77E-05	9.32E-09
Bromomethane	Ingestion of Surface Water	1.00E-03	mg/l	2.68E-04		1.25E-03	
Chrysene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-10		1.10E-09
Dibenz(a,h)anthracene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-07		1.10E-06
Dichlorobenzidine, 3,3'	Ingestion of Surface Water	3.50E-03	mg/l		1.52E-07		2.37E-07
Dichloroethane, 1,2-	Ingestion of Surface Water	1.00E-03	mg/l		8.79E-09		1.37E-08
Dichloroethene, 1,1-	Ingestion of Surface Water	1.00E-03	mg/l		5.80E-08	1.95E-04	9.02E-08
Dichloropropane, 1,2-	Ingestion of Surface Water	1.00E-03	mg/l	4.17E-05	6.57E-09		1.02E-08
Dichloropropene, Cis-1,3-	Ingestion of Surface Water	5.00E-04	mg/l				
Dichloropropene, Trans-1,3-	Ingestion of Surface Water	1.00E-03	mg/l				
Dinitrophenol, 2,4-	Ingestion of Surface Water	1.50E-02	mg/l	2.82E-03		1.32E-02	
Dinitrotoluene, 2,4-	Ingestion of Surface Water	2.00E-03	mg/l	3.76E-04		1.75E-03	
Dinitrotoluene, 2,6-	Ingestion of Surface Water	2.50E-03	mg/l	9.39E-04		4.38E-03	
Hexachlorobenzene	Ingestion of Surface Water	1.00E-03	mg/l	4.70E-04	1.55E-07	2.19E-03	2.40E-07
Hexachlorobutadiene	Ingestion of Surface Water	1.00E-03	mg/l		7.54E-09		1.17E-08
Indeno(1,2,3-cd)pyrene	Ingestion of Surface Water	1.00E-03	mg/l		7.05E-08		1.10E-07
Nitroaniline, 2-	Ingestion of Surface Water	1.00E-03	mg/l				
Nitroaniline, 3-	Ingestion of Surface Water	2.00E-03	mg/l	1.25E-02		5.84E-02	
Nitroaniline, 4-	Ingestion of Surface Water	1.00E-02	mg/l	1.25E-03		5.84E-03	
Nitrosodi-N-propylamine, N-	Ingestion of Surface Water	7.00E-03	mg/l	8.77E-04		4.09E-03	
Oxybis(1-chloropropane), 2,2'-	Ingestion of Surface Water	2.00E-03	mg/l		1.35E-06		2.10E-06
	Ingestion of Surface Water	5.00E-04	mg/l				

Table F-10. Carcinogenic and Non-carcinogenic Risk Values for Non-detected COPCs at the Western Drainage area, Koztebue LRRS

ANALYTE	EXPOSURE PATHWAY	EXPOSURE POINT CONCENTRATION	UNITS	ADULT HAZARD INDEX	ADULT CANCER RISK	CHILD HAZARD INDEX	CHILD CANCER RISK
Pentachlorophenol	Ingestion of Surface Water	6.00E-03	mg/l	7.51E-05	6.96E-08	3.51E-04	1.08E-07
Toxaphene	Ingestion of Surface Water	3.95E-04	mg/l		4.20E-08		6.53E-08
Trichloroethane, 1,1,2-	Ingestion of Surface Water	5.00E-04	mg/l	4.70E-05	2.75E-09	2.19E-04	4.28E-09
Trichlorophenol, 2,4,6-	Ingestion of Surface Water	2.50E-03	mg/l		2.66E-09		4.13E-09
Vinyl Chloride	Ingestion of Surface Water	1.00E-03	mg/l		1.84E-07		2.86E-07
TOTAL RISK				6.84E+00	1.46E-03	2.85E+01	1.76E-03

APPENDIX G

SPECIES IDENTIFIED IN THE KOTZEBUE AREA

APPENDIX G

SPECIES IDENTIFIED IN THE KOTZEBUE AREA

CONTENTS

- G-1 Zooplankton Identified in Kotzebue Sound
- G-2 Benthic Invertebrates Identified in Kotzebue Sound
- G-3 Marine Fishes Identified in Nearshore Areas of Kotzebue Sound
- G-4 Densities and Percent Frequency of Occurrence of Seabirds in Kotzebue Sound, 15-16 September 1976
- G-5 Marine Mammals that Occur in Kotzebue Sound
- G-6 Selected List of Edible Terrestrial Plants of Kotzebue
- G-7 Terrestrial Mammals Identified in the Greater Kotzebue Region

TABLE G-1. ZOOPLANKTON IDENTIFIED IN KOTZEBUE SOUND

<u>Taxonomic group</u>	<u>Scientific name</u>
Hydrozoa	<i>Perigoniurus yolidia-arcticae</i> <i>Obelia longissima</i> <i>Aglantha digitale</i> <i>Polypoid larvae</i>
Scyphozoa	<i>Cyanea capillata</i>
Ctenophora	<i>sp.</i>
Polychaeta	<i>Polynoidae</i> (larvae) <i>Spionidae</i> (larvae)
Cladocera	<i>Evadne sp.</i> <i>Podon sp.</i>
Copepoda	<i>Calanus glacialis</i> <i>Pseudocalanus spp.</i> <i>Centropages abdominalis</i> <i>Acartia longiremis</i> <i>Acartia clausi</i> <i>Oithona similis</i>
Cirripedia	<i>Cypris larvae</i>
Decapoda	<i>Paguridae</i> (larvae) <i>Oregoniidae</i> (larvae)
Chaetognatha	<i>Sagitta elegans</i> Unidentified juveniles
Urochordata	<i>Fritillaria borealis</i>

SOURCE: Hameedi 1988

TABLE G-2. BENTHIC INVERTEBRATES IDENTIFIED IN KOTZEBUE SOUND.

Phylum	Leading species	Common name	Feeding method ¹	Avg. wt. per individual g	% wt. of phylum	% wt. of all phyla
Echinodermata	<i>Asterias amurensis</i>	sea star	P	202	35.54	21.21
	<i>Leptasterias polaris acervata</i>	sea star	P	96	20.90	12.47
	<i>Strongylocentrotus droebachiensis</i>	green sea urchin	H-S-P	70	10.69	6.38
	<i>Lethasterias nanimensis</i>	sea star	P	299	9.67	5.77
	<i>Evasterias echinomosa</i>	sea star	P	656	6.39	3.81
	<i>Gorgonocephalus caryi</i>	basket star	Sus-P	258	5.76	3.44
			Total	88.95		53.08
Mollusce	<i>Neptunea heros</i>	snail	P-S	101	79.98	10.19
	<i>Neptunea ventricosa</i>	snail	P-S	71	10.80	1.38
	<i>Beromgois beromgo</i>	snail	P-S	85	2.35	0.30
			Total	93.13		11.87
Arthropoda (Crustacea)	<i>Chionoecetes opilio</i>	opilio Tanner crab	P-S	27	43.76	5.46
	<i>Pagurus trigonochelirus</i>	hermit crab	P-S?	17	15.77	1.97
	<i>Hyas coarctatus alutaceus</i>	crab	P-S?	25	12.87	1.61
	<i>Telemessus cheiragonus</i>	brachyuran crab	P-S?	133	7.43	0.93
	<i>Pagurus capillatus</i>	hermit crab	P-S?	12	7.24	0.90
	<i>Argis lar</i>	crangonid shrimp	S?	7	4.34	0.54
			Total	91.41		11.41

¹Feeding methods: P=predator; P-S=predator-scavenger; S=scavenger; Sus=suspension feeder; Sus-P=suspension feeder-predator; H-S-P=herbivore-scavenger-predator.

SOURCE: Feder and Jewett (1988)

TABLE G-3. MARINE FISHES IDENTIFIED IN NEARSHORE AREAS OF KOTZEBUE SOUND.

Taxonomic group	Scientific name	Common name
Phylum Arthropoda, Class Crustacea		
Crangonidae	<i>Crangon septemspinosa</i>	shrimp
Phylum Chordata, Superclass Pisces		
Clupeidae	<i>Clupea harengus pallasi</i>	Pacific herring
Salmonidae	<i>Onchorhynchus keta</i> <i>Oncorhynchus gorboscha</i> <i>Salvelinus alpinus</i> <i>Coregonus pidschian</i> <i>Coregonus nasus</i> <i>Prosopium cylindraceum</i> <i>Coregonus sardinella</i> <i>Coregonus laurettae</i> <i>Stenodus leucichthys</i>	Chum salmon Pink salmon Arctic char Humpback whitefish Broad whitefish Round whitefish Least cisco Bering cisco Sheefish
Osmeridae	<i>Osmerus mordax dentex</i> <i>Hypomesus olidus</i> <i>Mallotus villosus</i>	Rainbow smelt Pond smelt capelin
Gadidae	<i>Eleginus gracilis</i>	Saffron, Gray, or Pacific cod
Gasterosteidae	<i>Pungitius pungitius</i>	Nine-spine stickleback
Cottidae		sculpin spp.
Agonidae	<i>Agonus acipenserinus</i>	Sturgeon poacher
Stichaeidae	<i>Lumpenus sagitta</i> ?	Snake prickleback
Ammodytidae	<i>Ammodytes hexapterus</i>	Pacific sand lance
Pleuronectidae	<i>Platichthys stellatus</i> <i>Liopsetta glacialis</i> <i>Limanda aspera</i>	Starry flounder Arctic flounder Yellowfin sole

SOURCE: Raymond et al. (1984)

TABLE G-4. DENSITIES AND PERCENT FREQUENCY OF OCCURRENCE
OF SEABIRDS IN KOTZEBUE SOUND, 15-16 SEPTEMBER 1976.

Species or species group	Density (birds/sq. km)	Percent frequency of occurrence
Loons	0.4	20
Northern fulmar	0	0
Short-tailed shearwater	0.1	2
Oldsquaw	0.1	2
Eiders	0	0
Phalaropes	0.7	4
Glaucous gul	0.1	5
Black-legged kittiwake	0.9	31
Ross Gull	0	0
Murres	0.1	6
Crested auklet	0.1	6
Least auklet	0	0
Parakeet auklet	0.1	6
Horned puffin	0.1	6
n=65	2.7	51

SOURCE: Divoky and Springer (1988)

TABLE G-5. MARINE MAMMALS THAT OCCUR IN KOTZEBUE SOUND.

Taxonomic group	Scientific name	Common name
Cetaceans	<i>Delphinapterus leucas</i>	Belukha whale
	<i>Orcinus orca</i>	Killer whale
	<i>Phocoena phocoena</i>	Harbor porpoise
	<i>Eschrichtius robustus</i>	Gray whale
	<i>Balaenoptera acutorostrata</i>	Minke whale
	<i>Balaena mysticetus</i>	Bowhead whale
Pinnipeds	<i>Phoca hispida</i>	Ringed seal
	<i>Phoca largha</i>	Spotted seal
	<i>Erignathus barbatus</i>	Bearded seal
	<i>Odobenus rosmarus</i>	Pacific Walrus
	<i>Ursus maritimus</i>	Polar bear
SOURCE: Frost and Lowry (1988)		

TABLE G-6. SELECTED LIST OF EDIBLE TERRESTRIAL PLANTS OF KOTZEBUE.

Family	Scientific name	Common name
Salicaceae	<i>Salix pulchra</i>	Sura willow
Rosaceae	<i>Rubus chamaemorus</i>	Salmonberry, Cloudberry
Ericaceae	<i>Vaccinium uliginosum</i> <i>Vaccinium vitis-idaea</i> <i>Ledum palustre</i> (<i>L. decumbens</i>)	Blueberry Lowbush cranberry Eskimo tea
Empetraceae	<i>Empetrum nigrum</i>	Blackberry, Crowberry
Onagraceae	<i>Epilobium angustifolium</i> <i>Epilobium latifolium</i>	Fireweed Dwarf fireweed
Polygonaceae	<i>Rumex arcticus</i> <i>Polygonum bistorta</i> <i>Polygonum alaskanum</i>	Sourdock Pink plume, bistort Wild rhubarb
Compositae	<i>Hedysarum alpinum</i> <i>Petasites frigida</i>	Eskimo potato Coltsfoot
Cyperaceae	<i>Carex</i> sp. <i>Eriophorum angustifolium</i>	Sedge Tall cottongrass
Umbelliferae	<i>Angelica lucida</i> <i>Ligusticum scoticum</i>	Wild celery Sea lovage
Equisetaceae	<i>Equisetum pratense</i>	Horsetail rush
Saxifragaceae	<i>Saxifraga punctata</i>	Brook saxifrage, salad greens
Liliaceae	<i>Allium schoenoprasum</i>	Wild chive
Caryophyllaceae	<i>Honckenya peploides</i>	Beach greens
Crassulaceae	<i>Sedum roseum</i>	Roseroot
Scrophulariaceae	<i>Pedicularis lanata</i> (<i>Kanei</i>)	Woolly lousewort

SOURCE: Jones (1983)

TABLE G-7. TERRESTRIAL MAMMALS IDENTIFIED IN THE GREATER KOTZEBUE REGION.

<u>Scientific name</u>	<u>Common name</u>
<i>Sorex arcticus</i>	Arctic shrew
<i>Sorex cinereus</i>	Masked shrew
<i>Ursus horribilis</i>	Grizzly bear
<i>Ursus maritimus</i>	Polar bear
<i>Canis lupus</i>	Wolf
<i>Alopex labopus</i>	Arctic fox
<i>Vulpes fulva</i>	Red fox
<i>Mustela erminea</i>	Ermine
<i>Mustela rixosa</i>	Least weasel
<i>Gulo luscus</i>	Wolverine
<i>Citellus parryi</i>	Arctic ground squirrel
<i>Marmota caligata</i>	Hoary marmot
<i>Clethrionomys rutilus</i>	Red-backed vole
<i>Microtus oeconomus</i>	Tundra vole
<i>Microtus miurus</i>	Alaska vole
<i>Ondatra zibethicus</i>	Muskrat
<i>Lemmus trimucronatus</i>	Brown lemming
<i>Dicrostonyx groenlandicus</i>	Collared lemming
<i>Erethizon dorsatum</i>	Porcupine
<i>Alces alces</i>	Moose
<i>Rangifer tarandus</i>	Barren-ground caribou
<i>Canis latrans</i>	Coyote
<i>Mustela vison</i>	Mink
<i>Lutra canadensis</i>	River otter
<i>Lynx canadensis</i>	Lynx

SOURCE: Pruitt (1966)

APPENDIX H

RISK ESTIMATES FOR BASELINE ECOLOGICAL RISK ASSESSMENT

APPENDIX H

RISK ESTIMATES FOR BASELINE ECOLOGICAL RISK ASSESSMENT

CONTENTS

- H-1 Risk Characterization for the Ringed Seal Dietary Pathway at the Beach Site
- H-2 Risk Characterization for the Caribou Dietary Pathway at the White Alice Site
- H-3 Risk Characterization for the Caribou Dietary Pathway at the Beach Site
- H-4 Risk Characterization for the Caribou Dietary Pathway at the East Drainage Site
- H-5 Risk Characterization for the Caribou Dietary Pathway at the West Drainage Site
- H-6 Risk Characterization for the Ground Squirrel Dietary Pathway at the White Alice Site
- H-7 Risk Characterization for the Ground Squirrel Dietary Pathway at the Beach Site
- H-8 Risk Characterization for the Ground Squirrel Dietary Pathway at the East Drainage Site
- H-9 Risk Characterization for the Ground Squirrel Dietary Pathway at the West Drainage Site
- H-10 Risk Characterization for the Ground Squirrel Ingestion Pathway at the White Alice Site

- H-11 Risk Characterization for the Ground Squirrel Ingestion Pathway at the Beach Site
- H-12 Risk Characterization for the Ground Squirrel Ingestion Pathway at the East Drainage Site
- H-13 Risk Characterization for the Ground Squirrel Soil Ingestion Pathway at the West Drainage Site
- H-14 Risk Characterization for the Caribou Water Ingestion Pathway at the White Alice Site
- H-15 Risk Characterization for the Caribou Water Ingestion Pathway at the East Drainage Site
- H-16 Risk Characterization for the Caribou Water Ingestion Pathway at the West Drainage Site
- H-17 Risk Characterization for the Ground Squirrel Water Ingestion Pathway at the White Alice Site
- H-18 Risk Characterization for the Ground Squirrel Water Ingestion Pathway at the East Drainage Site
- H-16 Risk Characterization for the Ground Squirrel Water Ingestion Pathway at the West Drainage Site

Table H-1. Risk Characterization for Contaminated Seal Dietary Pathway at the Beach Site

COPEC	Type	Conc. ($\mu\text{g/L}$ organics, mg/L metals)	Conc/dilution ($\mu\text{g/L}$ organics, mg/L metals)	Log BCF	Fish conc. (mg/kg)	ADD-diet seal (mg/kg/day)	HQ-diet seal
Arochlor 1254	2	5.00E-01	2.50E-07	5.66	1.14E-04	4.57E-06	3.26E-04
4,4'-DDT	1	4.00E-01	2.00E-07	5.00	2.00E-05	8.00E-07	1.60E-04
Heptachlor Epoxide	2	5.00E-03	2.50E-09	4.16	3.61E-08	1.45E-09	1.16E-04
alpha-Chlordane	2	5.00E-03	2.50E-09	6.34	5.47E-06	2.19E-07	8.75E-05
Arochlor 1260	2	5.00E-01	2.50E-07	5.57	9.29E-05	3.72E-06	5.02E-05
Xylenes, total	3	2.14E+02	1.07E-04	2.20	1.70E-05	6.80E-07	3.30E-05
2-Methylnaphthalene	3	8.17E+01	4.09E-05	2.28	7.79E-06	3.12E-07	9.56E-06
Toxaphene	2	3.95E-01	1.98E-07	4.84	1.37E-05	5.47E-07	5.47E-06
Arochlor 1242	2	3.50E-01	1.75E-07	5.44	4.82E-05	1.93E-06	5.27E-06
Manganese	3	2.99E-01	1.49E-07	0.00	1.49E-07	5.97E-09	4.27E-06
Endrin	2	7.00E-03	3.50E-09	3.85	2.48E-08	9.91E-10	3.96E-06
gamma-Chlordane	2	5.00E-03	2.50E-09	6.34	5.47E-06	2.19E-07	1.95E-06
Hexachlorocyclopentadiene	2	2.30E+01	1.15E-05	3.09	1.41E-05	5.66E-07	1.35E-06
Acenaphthylene	3	1.98E+00	9.62E-07	2.76	5.54E-07	2.21E-08	6.51E-07
Heptachlor	2	5.00E-03	2.50E-09	3.98	2.39E-08	9.55E-10	6.37E-07
Mercury	1	4.68E-05	2.34E-11	4.00	2.34E-07	9.36E-09	2.18E-07
Methoxychlor	2	6.00E-02	3.00E-08	3.92	2.50E-07	9.98E-09	1.99E-07
Fluorene	3	2.47E+00	1.24E-06	3.17	1.83E-06	7.31E-08	5.85E-08
Dieldrin	2	1.00E-02	5.00E-09	3.78	3.01E-08	1.21E-09	4.02E-08
4-Methylphenol	3	3.13E+00	1.57E-06	1.26	2.85E-08	1.14E-09	2.28E-08
Benzoic Acid	3	1.79E+01	8.57E-06	2.00	8.57E-07	3.43E-08	1.10E-08
Cadmium	2	1.00E-02	5.00E-09	0.00	5.00E-09	2.00E-10	9.30E-09
di-n-butyl Phthalate	2	7.50E+00	3.75E-06	1.07	4.41E-08	1.76E-09	1.41E-09
Silver	2	2.00E-03	1.00E-09	0.00	1.00E-09	4.00E-11	4.00E-10
Diethyl Phthalate	2	8.00E+00	4.00E-06	1.18	6.05E-08	2.42E-09	3.23E-10
Acetone	3	8.00E+00	7.59E-06	-0.16	5.25E-09	2.10E-10	2.10E-10
Carbon Disulfide	3	1.00E+00	1.38E-06	0.00	1.38E-09	5.50E-11	1.57E-10
Methyl Ethyl Ketone (2-butanone)	3	3.63E+00	1.81E-06	0.00	1.81E-09	7.25E-11	4.24E-12
Arochlor 1016	2	4.50E-01	2.25E-07	5.50	7.12E-05	2.85E-06	a
Arochlor 1221	2	4.00E-01	2.00E-07	5.50	6.32E-05	2.53E-06	a
Arochlor 1232	2	4.00E-01	2.00E-07	5.50	6.32E-05	2.53E-06	a
Arochlor 1248	2	4.00E-01	2.00E-07	5.50	6.32E-05	2.53E-06	a
Dibenzofuran	3	1.00E+00	9.51E-07	3.23	1.62E-06	6.46E-08	a
a = no toxicity value available							

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-2. Risk Characterization for the Caribou Dietary Pathway at the White Alice Site

COPEC	Type	Site	Soil Conc. (mg/kg)	SCF	Plant Conc. (mg/kg)	ADD-diet caribou (mg/kg/day)	HQ-diet caribou
2-Methylnaphthalene	1	Alice	1.00E+00	5.00E-01	5.00E-01	8.04E-04	2.47E-02
4-Methylphenol	3	Alice	1.20E+00	5.00E-01	6.00E-01	9.65E-04	1.93E-02
Phenol	3	Alice	2.00E-01	5.89E-01	1.18E-01	1.89E-04	1.89E-02
Methylene Chloride	3	Alice	1.65E-01	7.56E-01	1.24E-01	2.00E-04	3.42E-03
1,1-Dichloroethene	2	Alice	3.40E-01	5.00E-01	1.70E-01	2.73E-04	1.37E-03
Acetone	3	Alice	6.29E-01	6.06E-01	3.81E-01	6.13E-04	6.13E-04
Toxaphene	2	Alice	6.50E-01	5.00E-02	3.25E-02	5.23E-05	5.23E-04
Xylenes, total	3	Alice	4.00E-03	8.15E-01	3.26E-03	5.24E-06	2.54E-04
Endrin	1	Alice	5.42E-02	2.36E-04	1.28E-05	2.06E-08	8.23E-05
Dimethylphthalate	3	Alice	9.70E-01	5.17E-01	5.02E-01	8.07E-04	8.07E-05
Methyl Ethyl Ketone (2-butanone)	3	Alice	3.40E-01	1.02E+00	3.47E-01	5.58E-04	3.26E-05
Dieldrin	1	Alice	4.09E-03	3.72E-02	1.52E-04	2.45E-07	8.15E-06
Fluorene	1	Alice	2.42E+00	1.00E-03	2.42E-03	3.90E-06	3.12E-06
1,1,2-Trichloro-1,2,2-trifluoroethane	3	Alice	2.00E-03	5.00E-01	1.00E-03	1.61E-06	1.87E-06
Toluene	3	Alice	1.40E-03	1.15E-01	1.61E-04	2.59E-07	1.16E-07
Arochlor 1260	1	Alice	2.10E+00	6.04E-07	1.27E-06	2.04E-09	2.75E-08
Dibenzo(a,h)anthracene	2	Alice	2.95E+00	9.13E-06	2.69E-05	4.33E-08	1.04E-08
Benzo(b)fluoranthene	1	Alice	1.00E-01	2.16E-06	2.16E-07	3.47E-10	1.81E-09
Cadmium	2	Alice	1.00E+00	a	--	--	--
Antimony	1	Alice	7.00E+00	a	--	--	--
Lead	1	Alice	1.50E+01	a	--	--	--
Arochlor 1016	2	Alice	9.00E-01	9.21E-05	8.29E-05	1.33E-07	b
Benzo(k)fluoranthene	2	Alice	1.00E+01	2.16E-06	2.16E-05	3.47E-08	b
Endrin Aldehyde	3	Alice	8.00E-04	1.00E-03	8.00E-07	1.29E-09	b
a = metals are assumed not be taken up by plants							
b = no toxicity value available							

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-3. Risk Characterization for the Caribou Dietary Pathway at the Beach Site

COPEC	Type	Site	Soil Conc. (mg/kg)	SCF	Plant Conc. (mg/kg)	ADD-diet caribou (mg/kg/day)	HQ-diet caribou
Xylenes, total	3	Beach	7.00E+00	8.15E-01	5.71E+00	9.18E-03	4.46E-01
2-Methylnaphthalene	1	Beach	1.60E+01	5.00E-01	8.00E+00	1.29E-02	3.95E-01
Methylene Chloride	3	Beach	2.36E-01	7.56E-01	1.78E-01	2.87E-04	4.90E-03
1,1-Dichloroethene	2	Beach	2.55E-01	5.00E-01	1.28E-01	2.05E-04	1.02E-03
Acetone	3	Beach	7.45E-01	6.06E-01	4.52E-01	7.26E-04	7.26E-04
Isophorone	3	Beach	8.59E-01	4.28E-01	3.67E-01	5.91E-04	3.94E-04
Ethylbenzene	3	Beach	1.91E-01	6.21E-02	1.18E-02	1.90E-05	2.72E-04
Toxaphene	2	Beach	1.25E-01	5.00E-02	6.25E-03	1.00E-05	1.00E-04
Methyl Ethyl Ketone (2-butanone)	3	Beach	4.42E-01	1.02E+00	4.51E-01	7.24E-04	4.23E-05
Endrin	1	Beach	4.85E-03	2.36E-04	1.15E-06	1.84E-09	7.37E-06
Fluorene	1	Beach	6.14E-01	1.00E-03	6.14E-04	9.86E-07	7.89E-07
Dibenzo(a,h)anthracene	2	Beach	4.00E-01	9.13E-06	3.65E-06	5.87E-09	1.41E-09
Cadmium	2	Beach	1.00E+00	a	--	--	--
Lead	1	Beach	3.10E+01	a	--	--	--
Dibenzofuran	3	Beach	4.22E-01	1.00E-02	4.22E-03	6.78E-06	b
Arochlor 1016	2	Beach	1.50E-01	9.21E-05	1.38E-05	2.22E-08	b
Benzo(k)fluoranthene	2	Beach	1.35E+00	2.16E-06	2.92E-06	4.69E-09	b
a = metals are assumed not be taken up by plants							
b = no toxicity value available							

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-4. Risk Characterization for the Caribou Dietary Pathway at the East Drainage Site

COPEC	Type	Site	Soil Conc. (mg/kg)	SCF	Plant Conc. (mg/kg)	ADD-diet caribou (mg/kg/day)	HQ-diet caribou
Xylenes, total	3	East	7.27E+00	8.15E-01	5.93E+00	9.53E-03	4.63E-01
4-Nitrophenol	3	East	4.10E+00	3.20E-01	1.31E+00	2.11E-03	4.22E-01
2-Methylnaphthalene	1	East	1.48E+01	5.00E-01	7.38E+00	1.19E-02	3.64E-01
Phenol	3	East	3.82E+00	5.89E-01	2.25E+00	3.62E-03	3.62E-01
2-Nitroaniline	3	East	1.16E+00	8.15E-01	9.48E-01	1.52E-03	7.12E-02
4-Methylphenol	3	East	5.00E-01	5.00E-01	2.50E-01	4.02E-04	8.04E-03
4-Nitroaniline	3	East	4.50E-01	8.15E-01	3.67E-01	5.90E-04	4.91E-03
Chloroform	3	East	5.14E-02	2.95E-01	1.52E-02	2.44E-05	4.87E-03
Methylene Chloride	3	East	1.63E-01	7.56E-01	1.24E-01	1.99E-04	3.40E-03
1,1-Dichloroethene	2	East	3.75E-01	5.00E-01	1.88E-01	3.01E-04	1.51E-03
Ethylbenzene	3	East	4.30E-01	6.21E-02	2.67E-02	4.29E-05	6.13E-04
Toxaphene	2	East	7.50E-01	5.00E-02	3.75E-02	6.03E-05	6.03E-04
Acetone	3	East	4.54E-01	6.06E-01	2.75E-01	4.42E-04	4.42E-04
Benzoic Acid	3	East	1.80E-01	3.38E-01	6.08E-02	9.78E-05	3.14E-05
Toluene	3	East	3.13E-01	1.15E-01	3.60E-02	5.78E-05	2.59E-05
Methyl Ethyl Ketone (2-butanone)	3	East	2.65E-01	1.02E+00	2.71E-01	4.35E-04	2.54E-05
Endrin	1	East	3.55E-03	2.36E-04	8.39E-07	1.35E-09	5.39E-06
cis-1,2-Dichloroethylene	3	East	2.00E-03	5.00E-01	1.00E-03	1.61E-06	5.02E-06
Dieldrin	1	East	1.52E-03	3.72E-02	5.66E-05	9.11E-08	3.04E-06
Fluorene	1	East	8.88E-01	1.00E-03	8.88E-04	1.43E-06	1.14E-06
Butylbenzylphthalate	3	East	4.29E-01	2.57E-03	1.10E-03	1.77E-06	1.11E-06
di-n-butyl Phthalate	3	East	1.00E-01	8.10E-04	8.10E-05	1.30E-07	1.04E-07
Dibenzo(a,h)anthracene	2	East	4.50E-01	9.13E-06	4.11E-06	6.61E-09	1.59E-09
Cadmium	2	East	2.00E+00	a	--	--	--
Antimony	1	East	4.00E+00	a	--	--	--
Lead	1	East	2.65E+01	a	--	--	--
2,4-Dinitrotoluene	3	East	1.37E+00	2.79E-01	3.82E-01	6.15E-04	b
Dibenzofuran	3	East	4.88E-01	1.00E-02	4.88E-03	7.84E-06	b
Arochlor 1016	2	East	9.00E-01	9.21E-05	8.29E-05	1.33E-07	b
Benzo(k)fluoranthene	2	East	1.45E+00	2.16E-06	3.13E-06	5.04E-09	b
Endrin Aldehyde	3	East	2.70E-03	1.00E-03	2.70E-06	4.34E-09	b
a = metals are assumed not be taken up by plants							
b = no toxicity value available							

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = screening value available; metal detected > 3X mean background conc.

Table H-5. Risk Characterization for the Caribou Dietary Pathway at the West Drainage Site

COPEC	Type	Site	Soil Conc. (mg/kg)	SCF	Plant Conc. (mg/kg)	ADD-diet caribou (mg/kg/day)	HQ-diet caribou
Xylenes, total	3	West	5.72E+01	8.15E-01	4.66E+01	7.50E-02	3.64E+00
2-Methylnaphthalene	1	West	2.10E+01	5.00E-01	1.05E+01	1.69E-02	5.17E-01
4-Nitrophenol	3	West	3.12E+00	3.20E-01	9.98E-01	1.60E-03	3.21E-01
2-Nitrophenol	3	West	1.36E+00	3.78E-01	5.14E-01	8.26E-04	1.24E-01
2-Hexanone	3	West	7.06E-01	5.00E-01	3.53E-01	5.67E-04	3.10E-02
4-Methylphenol	3	West	7.00E-01	5.00E-01	3.50E-01	5.63E-04	1.13E-02
2,6-Dinitrotoluene	3	West	9.69E-01	2.79E-01	2.70E-01	4.35E-04	1.09E-02
Phenol	3	West	1.00E-01	5.89E-01	5.89E-02	9.47E-05	9.47E-03
Methylene Chloride	3	West	2.86E-01	7.56E-01	2.16E-01	3.47E-04	5.94E-03
Ethylbenzene	3	West	3.00E+00	6.21E-02	1.86E-01	2.99E-04	4.27E-03
Toxaphene	2	West	3.35E+00	5.00E-02	1.68E-01	2.69E-04	2.69E-03
1,1-Dichloroethene	2	West	5.00E-01	5.00E-01	2.50E-01	4.02E-04	2.01E-03
Acetone	3	West	9.79E-01	6.06E-01	5.94E-01	9.54E-04	9.54E-04
2,4-Dichlorophenol	3	West	1.00E-01	1.06E-01	1.06E-02	1.70E-05	8.52E-04
Toluene	3	West	6.76E+00	1.15E-01	7.77E-01	1.25E-03	5.60E-04
Methyl Ethyl Ketone (2-butanone)	3	West	1.27E+00	1.02E+00	1.29E+00	2.08E-03	1.21E-04
cis-1,2-Dichloroethylene	3	West	2.40E-02	5.00E-01	1.20E-02	1.93E-05	6.03E-05
Benzoic Acid	3	West	3.20E-01	3.38E-01	1.08E-01	1.74E-04	5.57E-05
Endrin	1	West	1.61E-02	2.36E-04	3.79E-06	6.10E-09	2.44E-05
Dieldrin	1	West	2.80E-03	3.72E-02	1.04E-04	1.67E-07	5.58E-06
Fluorene	1	West	1.12E+00	1.00E-03	1.12E-03	1.80E-06	1.44E-06
Anthracene	1	West	8.00E-01	5.75E-03	4.60E-03	7.40E-06	7.40E-07
Dibenzo(a,h)anthracene	2	West	1.55E+00	9.13E-06	1.42E-05	2.28E-08	5.47E-09
Arochlor 1260	1	West	4.07E-01	6.04E-07	2.46E-07	3.95E-10	5.34E-09
Cadmium	2	West	1.00E+00	a	--	--	--
Lead	1	West	1.01E+01	a	--	--	--
2,4-Dinitrotoluene	3	West	4.86E-01	2.79E-01	1.36E-01	2.18E-04	b
Dibenzofuran	3	West	8.63E-01	1.00E-02	8.63E-03	1.39E-05	b
Arochlor 1016	2	West	9.00E-01	9.21E-05	8.29E-05	1.33E-07	b
Benzo(k)fluoranthene	2	West	5.00E+00	2.16E-06	1.08E-05	1.74E-08	b
Endrin Aldehyde	3	West	4.00E-04	1.00E-03	4.00E-07	6.43E-10	b
a = metals are assumed not be taken up by plants							
b = no toxicity value available							

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-6. Risk Characterization for the Ground Squirrel Dietary Pathway at the White Alice Site

COPEC	Type	Site	Soil Conc. (mg/kg)	SCF	Plant Conc. (mg/kg)	ADD-diet squirrel (mg/kg/day)	HQ-diet squirrel
4-Methylphenol	3	Alice	1.20E+00	5.00E-01	6.00E-01	9.84E-03	1.97E-01
2-Methylnaphthalene	1	Alice	1.00E+00	5.00E-01	5.00E-01	8.20E-03	1.51E-01
Methylene Chloride	3	Alice	1.65E-01	7.56E-01	1.24E-01	2.04E-03	2.09E-02
Phenol	3	Alice	2.00E-01	5.89E-01	1.18E-01	1.93E-03	1.93E-02
1,1-Dichloroethene	2	Alice	3.40E-01	5.00E-01	1.70E-01	2.79E-03	8.37E-03
Acetone	3	Alice	6.29E-01	6.06E-01	3.81E-01	6.26E-03	3.75E-03
Toxaphene	2	Alice	6.50E-01	5.00E-02	3.25E-02	5.33E-04	3.20E-03
Xylenes, total	3	Alice	4.00E-03	8.15E-01	3.26E-03	5.35E-05	1.56E-03
Endrin	1	Alice	5.42E-02	2.36E-04	1.28E-05	2.10E-07	8.40E-04
Dimethylphthalate	3	Alice	9.70E-01	5.17E-01	5.02E-01	8.23E-03	4.94E-04
Methyl Ethyl Ketone (2-butanone)	3	Alice	3.40E-01	1.02E+00	3.47E-01	5.70E-03	2.00E-04
Dieldrin	1	Alice	4.09E-03	3.72E-02	1.52E-04	2.50E-06	4.99E-05
Fluorene	1	Alice	2.42E+00	1.00E-03	2.42E-03	3.98E-05	1.91E-05
1,1,2-Trichloro-1,2,2-trifluoroethane	3	Alice	2.00E-03	5.00E-01	1.00E-03	1.64E-05	1.14E-05
Toluene	3	Alice	1.40E-03	1.15E-01	1.61E-04	2.64E-06	7.11E-07
Arochlor 1260	1	Alice	2.10E+00	6.04E-07	1.27E-06	2.08E-08	1.69E-07
Dibenzo(a,h)anthracene	2	Alice	2.95E+00	9.13E-06	2.69E-05	4.42E-07	6.37E-08
Benzo(b)fluoranthene	1	Alice	1.00E-01	2.16E-06	2.16E-07	3.54E-09	1.11E-08
Cadmium	2	Alice	1.00E+00	a	--	--	--
Antimony	1	Alice	7.00E+00	a	--	--	--
Lead	1	Alice	1.50E+01	a	--	--	--
Endrin Aldehyde	3	Alice	8.00E-04	1.00E-03	8.00E-07	1.31E-08	b
Arochlor 1016	2	Alice	9.00E-01	9.21E-05	8.29E-05	1.36E-06	b
Benzo(k)fluoranthene	2	Alice	1.00E+01	2.16E-06	2.16E-05	3.54E-07	b
a = metals are assumed not be taken up by plants							
b = no toxicity value available							

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = Screening value available; metal detected > 3X mean background conc.

Table H-7. Risk Characterization for the Ground Squirrel Dietary Pathway at the Beach Site

COPEC	Type	Site	Soil Conc. (mg/kg)	SCF	Plant Conc. (mg/kg)	ADD-diet squirrel (mg/kg/day)	HQ-diet squirrel
Xylenes, total	3	Beach	7.00E+00	8.15E-01	5.71E+00	9.37E-02	2.73E+00
2-Methylnaphthalene	1	Beach	1.60E+01	5.00E-01	8.00E+00	1.31E-01	2.42E+00
Methylene Chloride	3	Beach	2.36E-01	7.56E-01	1.78E-01	2.92E-03	3.00E-02
1,1-Dichloroethene	2	Beach	2.55E-01	5.00E-01	1.28E-01	2.09E-03	6.28E-03
Acetone	3	Beach	7.45E-01	6.06E-01	4.52E-01	7.41E-03	4.45E-03
Isophorone	3	Beach	8.59E-01	4.28E-01	3.67E-01	6.03E-03	4.02E-03
Ethylbenzene	3	Beach	1.91E-01	6.21E-02	1.18E-02	1.94E-04	1.67E-03
Toxaphene	2	Beach	1.25E-01	5.00E-02	6.25E-03	1.03E-04	6.15E-04
Methyl Ethyl Ketone (2-butanone)	3	Beach	4.42E-01	1.02E+00	4.51E-01	7.39E-03	2.59E-04
Endrin	1	Beach	4.85E-03	2.36E-04	1.15E-06	1.88E-08	7.52E-05
Fluorene	1	Beach	6.14E-01	1.00E-03	6.14E-04	1.01E-05	4.83E-06
Dibenzo(a,h)anthracene	2	Beach	4.00E-01	9.13E-06	3.65E-06	5.99E-08	8.64E-09
Cadmium	2	Beach	1.00E+00	a	--	--	--
Lead	1	Beach	3.10E+01	a	--	--	--
Arochlor 1016	2	Beach	1.50E-01	9.21E-05	1.38E-05	2.27E-07	b
Dibenzofuran	3	Beach	4.22E-01	1.00E-02	4.22E-03	6.92E-05	b
Benzo(k)fluoranthene	2	Beach	1.35E+00	2.16E-06	2.92E-06	4.78E-08	b
a = metals are assumed not be taken up by plants							
b = no toxicity value available							

Type:

- 1 = Detected concentration exceeded screening value
- 2 = PQL exceeded screening value
- 3 = No screening value available; chemical was detected
- 4 = No screening value available; metal detected > 3X mean background conc.

Table H-8. Risk Characterization for the Ground Squirrel Dietary Pathway at the East Drainage Site

COPEC	Type	Site	Soil Conc. (mg/kg)	SCF	Plant Conc. (mg/kg)	ADD-diet squirrel (mg/kg/day)	HQ-diet squirrel
Xylenes, total	3	East	7.27E+00	8.15E-01	5.93E+00	9.72E-02	2.83E+00
4-Nitrophenol	3	East	4.10E+00	3.20E-01	1.31E+00	2.15E-02	2.58E+00
2-Methylnaphthalene	1	East	1.48E+01	5.00E-01	7.38E+00	1.21E-01	2.23E+00
2-Nitroaniline	3	East	1.16E+00	8.15E-01	9.48E-01	1.55E-02	4.36E-01
Phenol	3	East	3.82E+00	5.89E-01	2.25E+00	3.69E-02	3.69E-01
4-Methylphenol	3	East	5.00E-01	5.00E-01	2.50E-01	4.10E-03	8.20E-02
4-Nitroaniline	3	East	4.50E-01	8.15E-01	3.67E-01	6.02E-03	3.01E-02
Chloroform	3	East	5.14E-02	2.95E-01	1.52E-02	2.49E-04	2.98E-02
Methylene Chloride	3	East	1.63E-01	7.56E-01	1.24E-01	2.03E-03	2.08E-02
1,1-Dichloroethene	2	East	3.75E-01	5.00E-01	1.88E-01	3.08E-03	9.23E-03
Ethylbenzene	3	East	4.30E-01	6.21E-02	2.67E-02	4.38E-04	3.75E-03
Toxaphene	2	East	7.50E-01	5.00E-02	3.75E-02	6.15E-04	3.69E-03
Acetone	3	East	4.54E-01	6.06E-01	2.75E-01	4.51E-03	2.71E-03
Benzoic Acid	3	East	1.80E-01	3.38E-01	6.08E-02	9.98E-04	3.20E-04
Toluene	3	East	3.13E-01	1.15E-01	3.60E-02	5.90E-04	1.59E-04
Methyl Ethyl Ketone (2-butanone)	3	East	2.65E-01	1.02E+00	2.71E-01	4.44E-03	1.56E-04
Endrin	1	East	3.55E-03	2.36E-04	8.39E-07	1.38E-08	5.51E-05
cis-1,2-Dichloroethylene	3	East	2.00E-03	5.00E-01	1.00E-03	1.64E-05	3.08E-05
Dieldrin	1	East	1.52E-03	3.72E-02	5.66E-05	9.29E-07	1.86E-05
Fluorene	1	East	8.88E-01	1.00E-03	8.88E-04	1.46E-05	7.00E-06
Butylbenzylphthalate	3	East	4.29E-01	2.57E-03	1.10E-03	1.81E-05	6.82E-06
di-n-butyl Phthalate	3	East	1.00E-01	8.10E-04	8.10E-05	1.33E-06	6.38E-07
Dibenzo(a,h)anthracene	2	East	4.50E-01	9.13E-06	4.11E-06	6.74E-08	9.72E-09
Cadmium	2	East	2.00E+00	a	--	--	--
Antimony	1	East	4.00E+00	a	--	--	--
Lead	1	East	2.65E+01	a	--	--	--
Endrin Aldehyde	3	East	2.70E-03	1.00E-03	2.70E-06	4.43E-08	b
Dibenzofuran	3	East	4.88E-01	1.00E-02	4.88E-03	8.00E-05	b
Arochlor 1016	2	East	9.00E-01	9.21E-05	8.29E-05	1.36E-06	b
2,4-Dinitrotoluene	3	East	1.37E+00	2.79E-01	3.82E-01	6.27E-03	b
Benzo(k)fluoranthene	2	East	1.45E+00	2.16E-06	3.13E-06	5.14E-08	b
a = metals are assumed not be taken up by plants							
b = no toxicity value available							

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = screening value available; metal detected > 3X mean background conc.

Table H-9. Risk Characterization for the Groundwater Squirrel Dietary Pathway at the West Drainage Site

COPEC	Type	Site	Soil Conc. (mg/kg)	SCF	Plant Conc. (mg/kg)	ADD-diet squirrel (mg/kg/day)	HQ-diet squirrel
Xylenes, total	3	West	5.72E+01	8.15E-01	4.66E+01	7.65E-01	2.23E+01
2-Methylnaphthalene	1	West	2.10E+01	5.00E-01	1.05E+01	1.72E-01	3.17E+00
4-Nitrophenol	3	West	3.12E+00	3.20E-01	9.98E-01	1.64E-02	1.97E+00
2-Nitrophenol	3	West	1.36E+00	3.78E-01	5.14E-01	8.43E-03	7.57E-01
2-Hexanone	3	West	7.06E-01	5.00E-01	3.53E-01	5.79E-03	1.90E-01
4-Methylphenol	3	West	7.00E-01	5.00E-01	3.50E-01	5.74E-03	1.15E-01
2,6-Dinitrotoluene	3	West	9.69E-01	2.79E-01	2.70E-01	4.44E-03	1.11E-01
Methylene Chloride	3	West	2.86E-01	7.56E-01	2.16E-01	3.55E-03	3.64E-02
Ethylbenzene	3	West	3.00E+00	6.21E-02	1.86E-01	3.05E-03	2.62E-02
Toxaphene	2	West	3.35E+00	5.00E-02	1.68E-01	2.75E-03	1.65E-02
1,1-Dichloroethene	2	West	5.00E-01	5.00E-01	2.50E-01	4.10E-03	1.23E-02
Phenol	3	West	1.00E-01	5.89E-01	5.89E-02	9.66E-04	9.66E-03
Acetone	3	West	9.79E-01	6.06E-01	5.94E-01	9.74E-03	5.84E-03
2,4-Dichlorophenol	3	West	1.00E-01	1.06E-01	1.06E-02	1.74E-04	5.22E-03
Toluene	3	West	6.76E+00	1.15E-01	7.77E-01	1.27E-02	3.43E-03
Methyl Ethyl Ketone (2-butanone)	3	West	1.27E+00	1.02E+00	1.29E+00	2.12E-02	7.44E-04
Benzoic Acid	3	West	3.20E-01	3.38E-01	1.08E-01	1.77E-03	5.69E-04
cis-1,2-Dichloroethylene	3	West	2.40E-02	5.00E-01	1.20E-02	1.97E-04	3.69E-04
Endrin	1	West	1.61E-02	2.36E-04	3.79E-06	6.22E-08	2.49E-04
Dieldrin	1	West	2.80E-03	3.72E-02	1.04E-04	1.71E-06	3.42E-05
Fluorene	1	West	1.12E+00	1.00E-03	1.12E-03	1.84E-05	8.81E-06
Anthracene	1	West	8.00E-01	5.75E-03	4.60E-03	7.55E-05	4.53E-06
Dibenzo(a,h)anthracene	2	West	1.55E+00	9.13E-06	1.42E-05	2.32E-07	3.35E-08
Arochlor 1260	1	West	4.07E-01	6.04E-07	2.46E-07	4.03E-09	3.27E-08
Cadmium	2	West	1.00E+00	a	--	--	--
Lead	1	West	1.01E+01	a	--	--	--
Endrin Aldehyde	3	West	4.00E-04	1.00E-03	4.00E-07	6.56E-09	b
2,4-Dinitrotoluene	3	West	4.86E-01	2.79E-01	1.36E-01	2.22E-03	b
Dibenzofuran	3	West	8.63E-01	1.00E-02	8.63E-03	1.42E-04	b
Arochlor 1016	2	West	9.00E-01	9.21E-05	8.29E-05	1.36E-06	b
Benzo(k)fluoranthene	2	West	5.00E+00	2.16E-06	1.08E-05	1.77E-07	b
a = metals are assumed not be taken up by plants							
b = no toxicity value available							

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-10. Risk Characterization for the Ground Squirrel Soil Ingestion Pathway at the White Alice Site

Chemical	Type	Site	Soil Conc. (mg/kg)	ADD-soil ingest (mg/kg/day)	HQ-soil ingest
Endrin	1	Alice	5.42E-02	2.44E-07	9.76E-04
Antimony	1	Alice	7.00E+00	3.15E-05	1.35E-04
Lead	1	Alice	1.50E+01	6.75E-05	1.35E-04
Cadmium	2	Alice	1.00E+00	4.50E-06	1.26E-04
4-Methylphenol	3	Alice	1.20E+00	5.40E-06	1.08E-04
2-Methylnaphthalene	1	Alice	1.00E+00	4.50E-06	8.28E-05
Arochlor 1260	1	Alice	2.10E+00	9.45E-06	7.66E-05
Toxaphene	2	Alice	6.50E-01	2.92E-06	1.75E-05
Phenol	3	Alice	2.00E-01	9.00E-07	9.00E-06
Methylene Chloride	3	Alice	1.65E-01	7.41E-07	7.60E-06
Fluorene	1	Alice	2.42E+00	1.09E-05	5.24E-06
1,1-Dichloroethene	2	Alice	3.40E-01	1.53E-06	4.59E-06
Dibenzo(a,h)anthracene	2	Alice	2.95E+00	1.33E-05	1.91E-06
Acetone	3	Alice	6.29E-01	2.83E-06	1.70E-06
Benzo(b)fluoranthene	1	Alice	1.00E-01	4.50E-07	1.41E-06
Xylenes, total	3	Alice	4.00E-03	1.80E-08	5.24E-07
Dieldrin	1	Alice	4.09E-03	1.84E-08	3.68E-07
Dimethylphthalate	3	Alice	9.70E-01	4.37E-06	2.62E-07
Methyl Ethyl Ketone (2-butanone)	3	Alice	3.40E-01	1.53E-06	5.37E-08
1,1,2-Trichloro-1,2,2-trifluoroethane	3	Alice	2.00E-03	9.00E-09	6.28E-09
Toluene	3	Alice	1.40E-03	6.30E-09	1.69E-09
Endrin Aldehyde	3	Alice	8.00E-04	3.60E-09	a
Arochlor 1016	2	Alice	9.00E-01	4.05E-06	a
Benzo(k)fluoranthene	2	Alice	1.00E+01	4.50E-05	a
a = no toxicity value available					

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-11. Risk Characterization for the Ground Squirrel Soil Ingestion Pathway at the Beach Site

Chemical	Type	Site	Soil Conc. (mg/kg)	ADD-soil ingest (mg/kg/day)	HQ-soil ingest
2-Methylnaphthalene	1	Beach	1.60E+01	7.20E-05	1.33E-03
Xylenes, total	3	Beach	7.00E+00	3.15E-05	9.18E-04
Lead	1	Beach	3.10E+01	1.39E-04	2.79E-04
Cadmium	2	Beach	1.00E+00	4.50E-06	1.26E-04
Endrin	1	Beach	4.85E-03	2.18E-08	8.74E-05
Methylene Chloride	3	Beach	2.36E-01	1.06E-06	1.09E-05
Ethylbenzene	3	Beach	1.91E-01	8.58E-07	7.35E-06
1,1-Dichloroethene	2	Beach	2.55E-01	1.15E-06	3.44E-06
Toxaphene	2	Beach	1.25E-01	5.62E-07	3.37E-06
Isophorone	3	Beach	8.59E-01	3.86E-06	2.58E-06
Acetone	3	Beach	7.45E-01	3.35E-06	2.01E-06
Fluorene	1	Beach	6.14E-01	2.76E-06	1.33E-06
Dibenzo(a,h)anthracene	2	Beach	4.00E-01	1.80E-06	2.60E-07
Methyl Ethyl Ketone (2-butanone)	3	Beach	4.42E-01	1.99E-06	6.97E-08
Arochlor 1016	2	Beach	1.50E-01	6.75E-07	a
Dibenzofuran	3	Beach	4.22E-01	1.90E-06	a
Benzo(k)fluoranthene	2	Beach	1.35E+00	6.07E-06	a
a = no toxicity value available					

Type:

- 1 = Detected concentration exceeded screening value
- 2 = PQL exceeded screening value
- 3 = No screening value available; chemical was detected
- 4 = No screening value available; metal detected > 3X mean background conc.

Table H-12. Risk Characterization for the Ground Squirrel Soil Ingestion Pathway at the East Site

Chemical	Type	Site	Soil Conc. (mg/kg)	ADD-soil ingest (mg/kg/day)	HQ-soil ingest
4-Nitrophenol	3	East	4.10E+00	1.85E-05	2.21E-03
2-Methylnaphthalene	1	East	1.48E+01	6.64E-05	1.22E-03
Xylenes, total	3	East	7.27E+00	3.27E-05	9.53E-04
Cadmium	2	East	2.00E+00	9.00E-06	2.51E-04
Lead	1	East	2.65E+01	1.19E-04	2.39E-04
Phenol	3	East	3.82E+00	1.72E-05	1.72E-04
2-Nitroaniline	3	East	1.16E+00	5.23E-06	1.47E-04
Antimony	1	East	4.00E+00	1.80E-05	7.71E-05
Endrin	1	East	3.55E-03	1.60E-08	6.40E-05
4-Methylphenol	3	East	5.00E-01	2.25E-06	4.50E-05
Chloroform	3	East	5.14E-02	2.31E-07	2.77E-05
Toxaphene	2	East	7.50E-01	3.37E-06	2.02E-05
Ethylbenzene	3	East	4.30E-01	1.93E-06	1.66E-05
4-Nitroaniline	3	East	4.50E-01	2.02E-06	1.01E-05
Methylene Chloride	3	East	1.63E-01	7.36E-07	7.54E-06
1,1-Dichloroethene	2	East	3.75E-01	1.69E-06	5.06E-06
Fluorene	1	East	8.88E-01	4.00E-06	1.92E-06
Acetone	3	East	4.54E-01	2.04E-06	1.22E-06
Butylbenzylphthalate	3	East	4.29E-01	1.93E-06	7.28E-07
Toluene	3	East	3.13E-01	1.41E-06	3.79E-07
Dibenzo(a,h)anthracene	2	East	4.50E-01	2.02E-06	2.92E-07
Benzoic Acid	3	East	1.80E-01	8.10E-07	2.60E-07
di-n-butyl Phthalate	3	East	1.00E-01	4.50E-07	2.16E-07
Dieldrin	1	East	1.52E-03	6.85E-09	1.37E-07
Methyl Ethyl Ketone (2-butanone)	3	East	2.65E-01	1.19E-06	4.19E-08
cis-1,2-Dichloroethylene	3	East	2.00E-03	9.00E-09	1.69E-08
Endrin Aldehyde	3	East	2.70E-03	1.21E-08	a
Dibenzofuran	3	East	4.88E-01	2.19E-06	a
Arochlor 1016	2	East	9.00E-01	4.05E-06	a
2,4-Dinitrotoluene	3	East	1.37E+00	6.16E-06	a
Benzo(k)fluoranthene	2	East	1.45E+00	6.52E-06	a
a = no toxicity value available					

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-13. Risk Characterization for the Ground Squirrel Soil Ingestion Pathway at the West Site

Chemical	Type	Site	Soil Conc. (mg/kg)	ADD-soil ingest (mg/kg/day)	HQ-soil ingest
Xylenes, total	3	West	5.72E+01	2.58E-04	7.50E-03
2-Methylnaphthalene	1	West	2.10E+01	9.43E-05	1.74E-03
4-Nitrophenol	3	West	3.12E+00	1.40E-05	1.68E-03
2-Nitrophenol	3	West	1.36E+00	6.11E-06	5.49E-04
Endrin	1	West	1.61E-02	7.23E-08	2.89E-04
Cadmium	2	West	1.00E+00	4.50E-06	1.26E-04
Ethylbenzene	3	West	3.00E+00	1.35E-05	1.16E-04
2,6-Dinitrotoluene	3	West	9.69E-01	4.36E-06	1.09E-04
2-Hexanone	3	West	7.06E-01	3.18E-06	1.04E-04
Lead	1	West	1.01E+01	4.53E-05	9.05E-05
Toxaphene	2	West	3.35E+00	1.51E-05	9.04E-05
4-Methylphenol	3	West	7.00E-01	3.15E-06	6.30E-05
Arochlor 1260	1	West	4.07E-01	1.83E-06	1.48E-05
2,4-Dichlorophenol	3	West	1.00E-01	4.50E-07	1.35E-05
Methylene Chloride	3	West	2.86E-01	1.29E-06	1.32E-05
Toluene	3	West	6.76E+00	3.04E-05	8.18E-06
1,1-Dichloroethene	2	West	5.00E-01	2.25E-06	6.75E-06
Phenol	3	West	1.00E-01	4.50E-07	4.50E-06
Acetone	3	West	9.79E-01	4.41E-06	2.64E-06
Fluorene	1	West	1.12E+00	5.04E-06	2.42E-06
Dibenzo(a,h)anthracene	2	West	1.55E+00	6.97E-06	1.01E-06
Benzoic Acid	3	West	3.20E-01	1.44E-06	4.61E-07
Dieldrin	1	West	2.80E-03	1.26E-08	2.52E-07
Anthracene	1	West	8.00E-01	3.60E-06	2.16E-07
cis-1,2-Dichloroethylene	3	West	2.40E-02	1.08E-07	2.02E-07
Methyl Ethyl Ketone (2-butanone)	3	West	1.27E+00	5.70E-06	2.00E-07
Endrin Aldehyde	3	West	4.00E-04	1.80E-09	a
2,4-Dinitrotoluene	3	West	4.86E-01	2.19E-06	a
Dibenzofuran	3	West	8.63E-01	3.88E-06	a
Arochlor 1016	2	West	9.00E-01	4.05E-06	a
Benzo(k)fluoranthene	2	West	5.00E+00	2.25E-05	a
a = no toxicity value available					

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-14. Risk Characterization for the Caribou Water Ingestion Pathway at the White Alice Site

chemical	type	site	SW Conc. ($\mu\text{g/L}$ organics, mg/L metals)	ADD-drink caribou (mg/kg/day)	HQ-drink caribou
Heptachlor Epoxide	1	Alice	2.00E-02	1.72E-07	1.37E-02
Cadmium	2	Alice	1.00E-02	8.58E-05	3.99E-03
Selenium	2	Alice	5.00E-02	4.29E-04	3.20E-03
delta BHC	3	Alice	3.82E-01	3.28E-06	2.78E-03
Methylene Chloride	3	Alice	3.00E+00	2.57E-05	4.40E-04
Endrin	2	Alice	7.00E-03	6.00E-08	2.40E-04
Silver	2	Alice	2.00E-03	1.72E-05	1.72E-04
Hexachlorocyclopentadiene	2	Alice	4.50E+00	3.86E-05	9.19E-05
Acetone	3	Alice	7.00E+00	6.00E-05	6.00E-05
Arochlor 1260	2	Alice	5.00E-01	4.29E-06	5.80E-05
Toxaphene	2	Alice	3.95E-01	3.39E-06	3.39E-05
alpha-Chlordane	2	Alice	5.00E-03	4.29E-08	1.72E-05
Methoxychlor	2	Alice	6.00E-02	5.15E-07	1.03E-05
Arochlor 1242	2	Alice	3.50E-01	3.00E-06	8.20E-06
gamma-Chlordane	2	Alice	5.00E-03	4.29E-08	3.83E-07
Arochlor 1221	2	Alice	4.00E-01	3.43E-06	a
Arochlor 1232	2	Alice	4.00E-01	3.43E-06	a
Arochlor 1248	2	Alice	4.00E-01	3.43E-06	a
Arochlor 1016	2	Alice	4.50E-01	3.86E-06	a
Arochlor 1254	2	Alice	5.00E-01	4.29E-06	a
a = no toxicity data available					

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-15. Risk Characterization for the Caribou Water Ingestion Pathway at the East Drainage Site

COPEC	type	site	SW Conc. ($\mu\text{g/L}$ organics, mg/L metals)	ADD-drink caribou (mg/kg/day)	HQ-drink caribou
Manganese	3	East	3.00E-02	2.57E-04	1.84E-01
Heptachlor Epoxide	1	East	1.20E-01	1.03E-06	8.23E-02
Cadmium	2	East	1.50E-02	1.29E-04	5.98E-03
Selenium	2	East	5.00E-02	4.29E-04	3.20E-03
Endrin	2	East	7.00E-03	6.00E-08	2.40E-04
Silver	2	East	2.00E-03	1.72E-05	1.72E-04
Hexachlorocyclopentadiene	2	East	4.50E+00	3.86E-05	9.19E-05
Arochlor 1260	2	East	5.00E-01	4.29E-06	5.80E-05
delta BHC	3	East	5.00E-03	4.29E-08	3.63E-05
Toxaphene	2	East	3.95E-01	3.39E-06	3.39E-05
alpha-Chlordane	2	East	5.00E-03	4.29E-08	1.72E-05
Barium	4	East	5.00E-02	4.29E-04	1.61E-05
Methoxychlor	2	East	6.00E-02	5.15E-07	1.03E-05
Arochlor 1242	2	East	3.50E-01	3.00E-06	8.20E-06
gamma-Chlordane	2	East	5.00E-03	4.29E-08	3.83E-07
Arochlor 1221	2	East	4.00E-01	3.43E-06	a
Arochlor 1232	2	East	4.00E-01	3.43E-06	a
Arochlor 1248	2	East	4.00E-01	3.43E-06	a
Arochlor 1016	2	East	4.50E-01	3.86E-06	a
Arochlor 1254	2	East	5.00E-01	4.29E-06	a
Magnesium	4	East	3.50E+00	3.00E-02	a
a = no toxicity data available					

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-16. Risk Characterization for the Caribou Water Ingestion Pathway at the West Drainage Site

chemical	type	site	SW Conc. ($\mu\text{g/L}$ organics, mg/L metals)	ADD-drink caribou (mg/kg/day)	HQ-drink caribou
Heptachlor Epoxide	1	West	2.47E-01	2.12E-06	1.70E-01
alpha BHC	3	West	9.94E-02	8.53E-07	7.23E-04
Heptachlor	1	West	5.00E-02	4.29E-07	2.86E-04
Endrin	2	West	7.00E-03	6.00E-08	2.40E-04
Acetone	3	West	2.09E+01	1.80E-04	1.80E-04
4,4'-DDT	1	West	7.48E-02	6.41E-07	1.28E-04
Hexachlorocyclopentadiene	2	West	4.50E+00	3.86E-05	9.19E-05
Arochlor 1260	2	West	5.00E-01	4.29E-06	5.80E-05
delta BHC	3	West	5.00E-03	4.29E-08	3.63E-05
Toxaphene	2	West	3.95E-01	3.39E-06	3.39E-05
Arochlor 1242	2	West	1.25E+00	1.07E-05	2.93E-05
alpha-Chlordane	2	West	5.00E-03	4.29E-08	1.72E-05
Methoxychlor	2	West	6.00E-02	5.15E-07	1.03E-05
Dieldrin	1	West	3.00E-02	2.57E-07	8.58E-06
Methyl Ethyl Ketone (2-butanone)	3	West	1.76E+00	1.51E-05	8.80E-07
gamma-Chlordane	2	West	5.00E-03	4.29E-08	3.83E-07
Endosulfan sulfate	3	West	4.30E-02	3.69E-07	a
Arochlor 1248	2	West	4.00E-01	3.43E-06	a
Arochlor 1254	2	West	5.00E-01	4.29E-06	a
Arochlor 1016	2	West	1.25E+00	1.07E-05	a
Arochlor 1232	2	West	1.25E+00	1.07E-05	a
Arochlor 1221	2	West	2.00E+00	1.72E-05	a
Magnesium	4	West	4.10E+01	3.52E-01	a
a = no toxicity data available					

Type:

- 1 = Detected concentration exceeded screening value
- 2 = PQL exceeded screening value
- 3 = No screening value available; chemical was detected
- 4 = No screening value available; metal detected > 3X mean background conc.

Table H-17. Risk Characterization for the Ground Squirrel Water Ingestion Pathway at the White Alice Site

COPEC	type	site	SW Conc. ($\mu\text{g/L}$ organics, mg/L metals)	ADD-drink squirrel (mg/kg/day)	HQ-drink squirrel
Heptachlor Epoxide	1	Alice	2.00E-02	8.43E-07	6.74E-02
Cadmium	2	Alice	1.00E-02	4.21E-04	1.18E-02
Selenium	2	Alice	5.00E-02	2.11E-03	9.44E-03
delta BHC	3	Alice	3.82E-01	1.61E-05	8.19E-03
Methylene Chloride	3	Alice	3.00E+00	1.26E-04	1.30E-03
Endrin	2	Alice	7.00E-03	2.95E-07	1.18E-03
Silver	2	Alice	2.00E-03	8.43E-05	5.06E-04
Hexachlorocyclopentadiene	2	Alice	4.50E+00	1.90E-04	4.52E-04
Acetone	3	Alice	7.00E+00	2.95E-04	1.77E-04
Arochlor 1260	2	Alice	5.00E-01	2.11E-05	1.71E-04
Toxaphene	2	Alice	3.95E-01	1.66E-05	9.99E-05
alpha-Chlordane	2	Alice	5.00E-03	2.11E-07	5.06E-05
Methoxychlor	2	Alice	6.00E-02	2.53E-06	5.05E-05
Arochlor 1242	2	Alice	3.50E-01	1.48E-05	2.42E-05
gamma-Chlordane	2	Alice	5.00E-03	2.11E-07	1.13E-06
Arochlor 1221	2	Alice	4.00E-01	1.69E-05	a
Arochlor 1232	2	Alice	4.00E-01	1.69E-05	a
Arochlor 1248	2	Alice	4.00E-01	1.69E-05	a
Arochlor 1016	2	Alice	4.50E-01	1.90E-05	a
Arochlor 1254	2	Alice	5.00E-01	2.11E-05	a
a = no toxicity data available					

Type:

- 1 = Detected concentration exceeded screening value
- 2 = PQL exceeded screening value
- 3 = No screening value available; chemical was detected
- 4 = No screening value available; metal detected > 3X mean background conc.

Table H-18. Risk Characterization for the Ground Squirrel Water Ingestion Pathway at the East Drainage Site

COPEC	type	site	SW Conc. (µg/L organics, mg/L metals)	ADD-drink squirrel (mg/kg/day)	HQ-drink squirrel
Manganese	3	East	3.00E-02	1.26E-03	9.03E-01
Heptachlor Epoxide	1	East	1.20E-01	5.06E-06	4.05E-01
Cadmium	2	East	1.50E-02	6.32E-04	1.76E-02
Selenium	2	East	5.00E-02	2.11E-03	9.44E-03
Endrin	2	East	7.00E-03	2.95E-07	1.18E-03
Silver	2	East	2.00E-03	8.43E-05	5.06E-04
Hexachlorocyclopentadiene	2	East	4.50E+00	1.90E-04	4.52E-04
Arochlor 1260	2	East	5.00E-01	2.11E-05	1.71E-04
delta BHC	3	East	5.00E-03	2.11E-07	1.07E-04
Toxaphene	2	East	3.95E-01	1.66E-05	9.99E-05
alpha-Chlordane	2	East	5.00E-03	2.11E-07	5.06E-05
Methoxychlor	2	East	6.00E-02	2.53E-06	5.05E-05
Barium	4	East	5.00E-02	2.11E-03	4.75E-05
Arochlor 1242	2	East	3.50E-01	1.48E-05	2.42E-05
gamma-Chlordane	2	East	5.00E-03	2.11E-07	1.13E-06
Arochlor 1221	2	East	4.00E-01	1.69E-05	a
Arochlor 1232	2	East	4.00E-01	1.69E-05	a
Arochlor 1248	2	East	4.00E-01	1.69E-05	a
Arochlor 1016	2	East	4.50E-01	1.90E-05	a
Arochlor 1254	2	East	5.00E-01	2.11E-05	a
Magnesium	4	East	3.50E+00	1.48E-01	a
a = no toxicity data available					

Type:

1 = Detected concentration exceeded screening value

2 = PQL exceeded screening value

3 = No screening value available; chemical was detected

4 = No screening value available; metal detected > 3X mean background conc.

Table H-19. Risk Characterization for the Ground Squirrel Water Ingestion Pathway at the West Drainage Site

COPEC	type	site	SW Conc. ($\mu\text{g/L}$ organics, mg/L metals)	ADD-drink squirrel (mg/kg/day)	HQ-drink squirrel
Heptachlor Epoxide	1	West	2.47E-01	1.04E-05	8.34E-01
alpha BHC	3	West	9.94E-02	4.19E-06	2.13E-03
Endrin	2	West	7.00E-03	2.95E-07	1.18E-03
Heptachlor	1	West	5.00E-02	2.11E-06	8.43E-04
4,4'-DDT	1	West	7.48E-02	3.15E-06	6.30E-04
Acetone	3	West	2.09E+01	8.82E-04	5.29E-04
Hexachlorocyclopentadiene	2	West	4.50E+00	1.90E-04	4.52E-04
Arochlor 1260	2	West	5.00E-01	2.11E-05	1.71E-04
delta BHC	3	West	5.00E-03	2.11E-07	1.07E-04
Toxaphene	2	West	3.95E-01	1.66E-05	9.99E-05
Arochlor 1242	2	West	1.25E+00	5.27E-05	8.64E-05
alpha-Chlordane	2	West	5.00E-03	2.11E-07	5.06E-05
Methoxychlor	2	West	6.00E-02	2.53E-06	5.05E-05
Dieldrin	1	West	3.00E-02	1.26E-06	2.53E-05
Methyl Ethyl Ketone (2-butanone)	3	West	1.76E+00	7.40E-05	2.59E-06
gamma-Chlordane	2	West	5.00E-03	2.11E-07	1.13E-06
Endosulfan sulfate	3	West	4.30E-02	1.81E-06	a
Arochlor 1248	2	West	4.00E-01	1.69E-05	a
Arochlor 1254	2	West	5.00E-01	2.11E-05	a
Arochlor 1016	2	West	1.25E+00	5.27E-05	a
Arochlor 1232	2	West	1.25E+00	5.27E-05	a
Arochlor 1221	2	West	2.00E+00	8.43E-05	a
Magnesium	4	West	4.10E+01	1.73E+00	a
a = no toxicity data available					

Type:

- 1 = Detected concentration exceeded screening value
- 2 = PQL exceeded screening value
- 3 = No screening value available; chemical was detected
- 4 = No screening value available; metal detected > 3X mean background conc.